TRACKING LIFE ON THE REEF
Benthic Communities and Zoning Performance

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Caribbean Coral Reef Decline

![Graph showing Caribbean Coral Reef Decline with events labeled: White Band Disease, Bleaching, Diadema Die-off, and Bleaching.](image)

Gardner et al. 2003 c/o Precht
Factors Affecting Coral Reefs in Florida

- Geography (winter cold fronts)
- Hurricanes
- Coral Disease
- Coral Bleaching
- Ocean Acidification
- Pollution
- Urchin die-off
- Over-fishing
- Marine zoning - but only if over-fishing is a major driver of change for coral reefs in the FKNMS.
Florida Keys

Upper Keys   Middle Keys   Lower Keys

Habitat Types   Habitat Types   Habitat Types

Ref Sites   NTZs   Ref Sites   NTZs   Ref Sites   NTZs

Ref Sites   NTZ   Ref Sites   NTZ   Ref Sites   NTZ

Ref Sites   NTZ   Ref Sites   NTZ   Ref Sites   NTZ
Regions Matter

Habitat Types Matter

Zones Matter - In some cases
Population trends for *Diadema*

**Mean density**
- Equation: $y = 0.0011x - 2.1586$
- $R^2 = 0.546$, $P < 0.025$

**Mean test diameter**
- Equation: $y = 0.2912x - 580.25$
- $R^2 = 0.903$, $P < 0.0005$
What do we measure?

1. Topographic Complexity (maximum vertical relief)
2. Coral Cover
3. Coral Density (>4cm)
4. Juvenile Coral Density (<4cm)
5. Coral Sizes
6. Seaweed Cover
7. Sponge Cover
8. Coral Species Richness
9. Sponge Species Richness
10. Gorgonian Species Richness
11. Gorgonian Density
12. Diadema Density
13. Diadema Sizes
14. Anemones
15. Corallimorpharians
16. Snail densities and sizes
17. Marine Debris
18. Candidate species for listing under the Endangered Species Act
19. Condition (bleaching, disease, and more)
20. More…
Expectations for NTZ Performance

UNDISTURBED CORAL REEF ECOSYSTEM: COMPLEX FOOD WEB; HIGH PREDATOR PRESSURE
Expectations for NTZ Performance

- **Stasis in Zones and Reference Areas**
  - Zones: Constant over time
  - Reference: Constant over time

- **Increase in Zones and Reference Areas**
  - Zones: Increase over time
  - Reference: Increase over time

- **Decline in Both Zones and Reference Areas**
  - Zones: Decrease over time
  - Reference: Decrease over time

- **Zones Increase, Reference Areas Decline**
  - Zones: Increase over time
  - Reference: Decrease over time

- **Zones Decrease, Reference Areas Increase**
  - Zones: Decrease over time
  - Reference: Increase over time

- **Zones Become Similar to Reference Areas**
  - Zones: Decrease over time
  - Reference: Decrease over time
Next Steps?

1. How can our results help inform your Work Group?

2. What do you want to accomplish?
   - Recommend new or modified ecological reserves to ensure protection of a diversity of resources, including... the full suite of marine flora and fauna.
   - Ensure the FKNMS zoning scheme promotes sustainable use of the sanctuary resources and protects areas that represent diverse habitats as well as areas important for maintaining natural resources and ecosystem functions.

3. Focus might range from species (Endangered Species Act, Spiny Lobster Amendment 11), to individual reefs (SPAs, ROs), to ecosystems (ERs).
Management: Species-based (Endangered Species Act)

<table>
<thead>
<tr>
<th>Species</th>
<th>Abundance</th>
<th>Abundance Protected</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. stokesi</td>
<td>49,735,917</td>
<td>2,154,458.52</td>
</tr>
<tr>
<td>M. faveolata</td>
<td>27,705,353</td>
<td>3,312,328.99</td>
</tr>
<tr>
<td>M. annularis</td>
<td>4,397,919</td>
<td>899,013.04</td>
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<tr>
<td>M. franksi</td>
<td>3,016,994</td>
<td>426,832.20</td>
</tr>
<tr>
<td>M. ferox</td>
<td>970,415</td>
<td>61,691.37</td>
</tr>
<tr>
<td>A. lamarcki</td>
<td>201,936</td>
<td>67,522.89</td>
</tr>
<tr>
<td>D. cylindrus</td>
<td>151,452</td>
<td>20,256.87</td>
</tr>
</tbody>
</table>

Green = Total Abundance  Blue = Protected Abundance
Acropora abundance

A. cervicornis

A. palmata

A. cervicornis 4.3% Keys-wide protection

A. palmata 33.3% Keys-wide protection
Manage Places (SPAs, ROs) to include what you think are the best sites, your favorite sites, or important sites?
<table>
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<th>Results that may help inform zoning interests at the ecosystem-scale</th>
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<td>1. Topographic Complexity (maximum vertical relief)</td>
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<td>20. Other</td>
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Benthic Surveys 2005-2009

- Survey Locations (n=444)
  
  FKNMS Boundary
  South Florida & Florida Keys
  Management Areas
Coral cover
Total Coral Cover

- Total coral cover:
  - N = 444 sites
  - Range = 0% to 58.3%
  - Mean = 7.3%

Zoning of top 10%:
- 30% of sites are in Sanctuary no-take zones
- 18% of sites are within Dry Tortugas NP

Habitat types of top 10%:
- 66% are shallower and deeper patch reefs
- 2% are high-relief spur and groove
- 25% are reef terrace and deeper fore-reef slope
Top Sites (Ranked Coral Cover)

- Low Rank
- Top 10% Rank

- FKNMS Boundary
- South Florida & Florida Keys
- Management Areas

Biscayne National Park
Upper Keys
Middle Keys
Lower Keys
Dry Tortugas
Abundance: Large Corals
Density of larger (50+ cm) corals

- N = 444 sites
- Range = 0 to 2.24 per m²
- Mean = 0.17 per m²

Zoning of top 10%:
- 52% of sites are in Sanctuary no-take zones

Habitat types of top 10%:
- 57% are patch reefs
- 27% are reef terraces in the Tortugas
Top Sites (Large Scleractinians)

Colony Density (col/m²)
- × Low Density
- ● Top 10% Density

Legend:
- FKNMS Boundary
- South Florida & Florida Keys
- Management Areas

Areas:
- Dry Tortugas
- Upper Keys
- Middle Keys
- Lower Keys

Distance Scale:
- 0 55 110 220 330 Kilometers
- 83°0'0"W 82°30'0"W 82°0'0"W 81°30'0"W 81°0'0"W 80°30'0"W 80°0'0"W
Juvenile Corals
Juvenile Coral Density

Juvenile coral density
- N = 444 sites
- Range = 0 to 32.1 per m²
- Mean = 5.8 per m²

Zoning of top 10%:
- 23% of sites are in Sanctuary no-take zones

Habitat types of top 10%:
- 55% are shallower and deeper patch reefs
- 32% are low-relief fore-reef habitats
Scleractinian Abundance: Top 15 species
Florida Keys 1999-2009 All Habitats

Juvenile Scleractinian Abundance: Top 15 species
Florida Keys 1999-2009 All Habitats
Total debris density (2012)
- N = 600 sites
- Mean = 0.88 items per 30 m$^2$ (range of 0 to 7)

Zoning of top 10%:
- 15% of sites are in Biscayne NP
- 12% of sites are in Sanctuary no-take zones
- Hen and Chickens SPA
- Cheeca Rocks SPA
- Sombrero Key SPA
- Looe Key RO
- Western Sambo ER

Habitat types of top 10%:
- 82% are patch reefs
Top Sites (Richness-based Scores)

RichSum
- Low Richness Score
- High Richness Score

- FKNMS Boundary
- South Florida & Florida Keys
- Management Areas

Dry Tortugas
Middle Keys
Upper Keys
**Top Sites (Coral-based Scores)**

- Low Coral Score
- High Coral Score

- **FKNMS Boundary**
- **South Florida & Florida Keys**
- **Management Areas**

*Map showing top sites based on coral health scores across different regions such as Biscayne National Park, Dry Tortugas, Upper Keys, Middle Keys, and Lower Keys.*
Conclusions

- We have a lot of data. Assembling and synthesizing our data (and data from other programs) to support your efforts to modify existing zones or propose new ones is not easy and it can’t be done quickly. You need a plan (Tortugas 2000 is a good model).

- System-wide, related to some of the iconic species found in the sanctuary, such as *Diadema*, and staghorn and elkhorn coral, and even pillar coral, populations are increasing or are relatively stable over the last ten years. This is good news.

- Related to NTZs, it’s a mixed bag. Community-level effects are likely to take a long time, if they occur at all. An important next step is to integrate our benthic data with the fish data that will be described in the next presentation.

- Questions? smiller@nova.edu, 305-451-9030
Acknowledgments