If you build it, will they come?

Exploring Enhancements to Artificial Structure for use in Restoration and Mitigation Applications

A. Kirk Kilfoyle[1], T. Patrick Quinn[1], Alasdair J. Edwards[2], David S. Gilliam[1], Richard E. Dodge[1], and Richard E. Spieler[1]

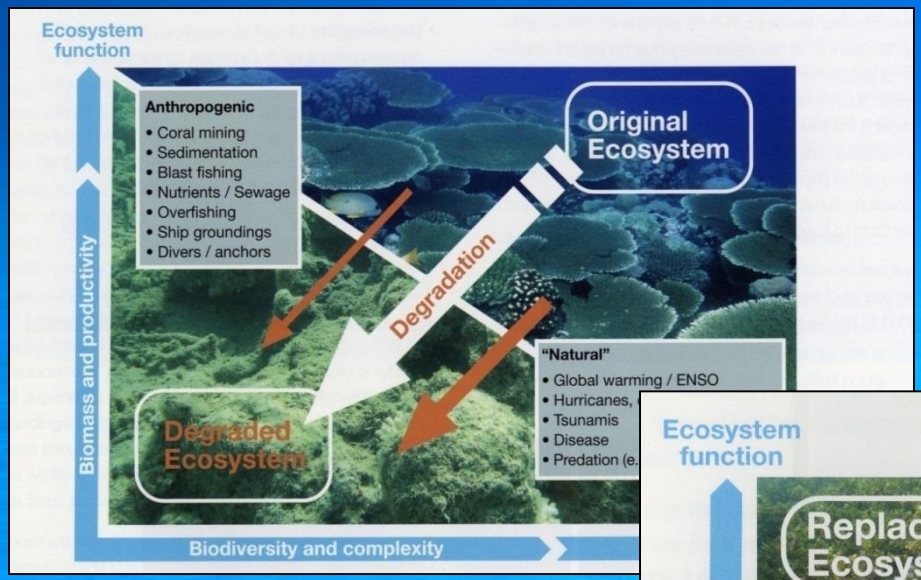
1) Nova Southeastern University Oceanographic Center

8000 North Ocean Drive, Dania Beach, FL 33004

2) Newcastle University

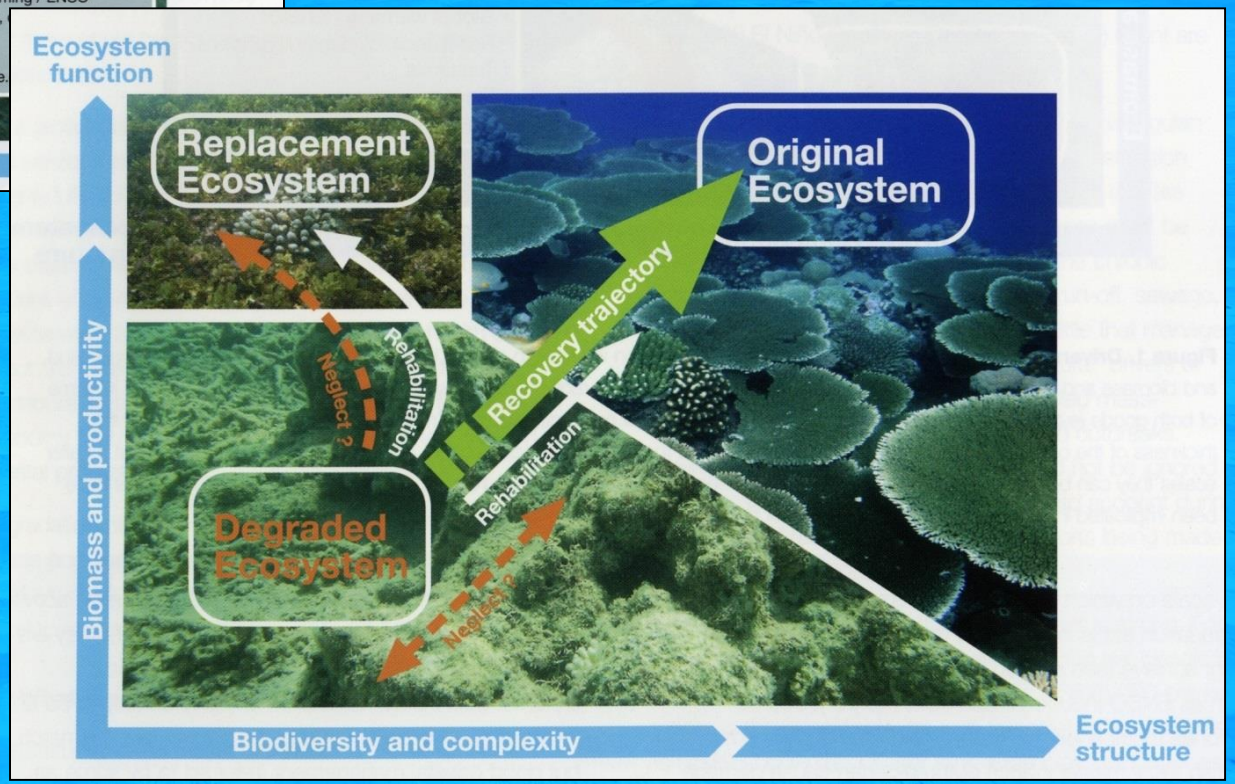
Newcastle upon Tyne, Tyne and Wear, NE1 7RU, UK

How do you determine if, and how much, direct intervention is warranted? When is it better to let natural rates of growth and community development dictate the pace of recovery?



Effects of Degradation on Ecosystem Structure and Function

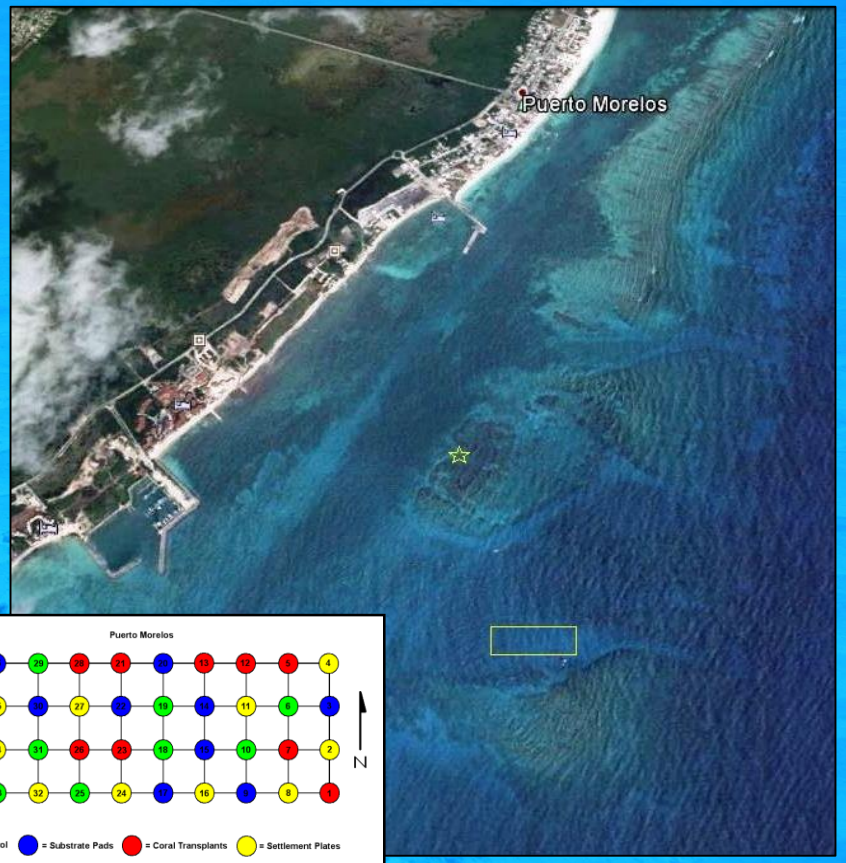
(From: Edwards and Gomez, 2007)



Possible Pathways to Recovery

AR Deployment Site

- Funded by World Bank and the Global Environmental Facility (GEF)
- Coral Reef Targeted Research (CRTR) and Capacity Building for Management Program



- Parque Nacional Arrecife de Puerto Morelos
- Universidad Nacional Autonoma de Mexico (UNAM) - Marine Science Laboratory
- Coral reef environment similar to Southeast Florida and the FL Keys

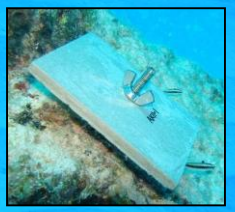
Experimental Design

- **Interventions / Treatments**
  - **Control (10)**
    - Un-altered substrate module (Reefball) used for standardizing substrate.
  - **Artificial Substrate Pads (10)**
    - Serves as refuge space for invertebrates; additional forage source for fishes.
  - **Coral Transplants (10)**
    - 6 corals (2 x 3 species) on each SM: *Orbicella annularis*, *Agaricia agaricites*, and *Porites astreoides.*
  - **Settlement Plates (10)**
    - Used to determine if low coral cover is the result of high post-settlement mortality or low recruitment rates.
  - **Natural Reef (5 x 10m transects)**
    - All parameters monitored on the SMs monitored in identical fashion on Natural Reef transects.



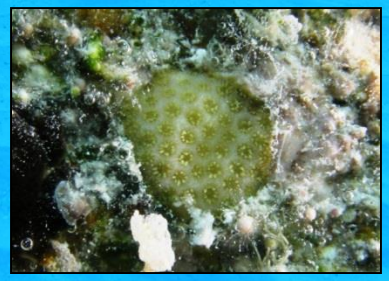


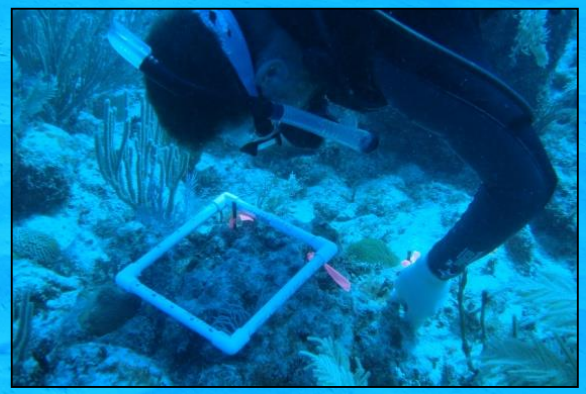




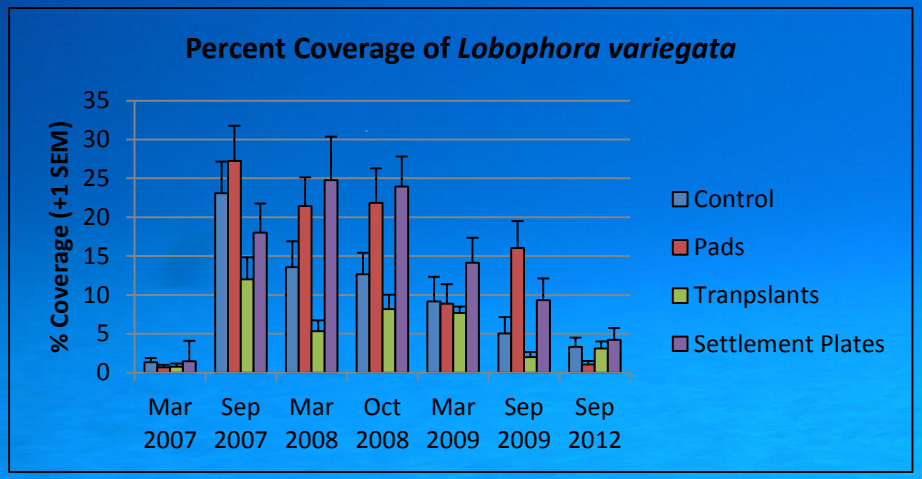
Methodology

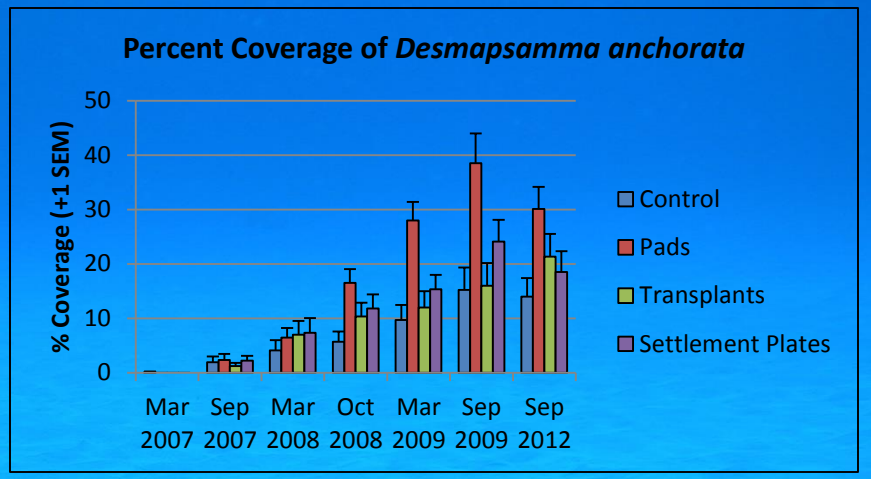
- Biannual monitoring trips
  - Fish counts
  - Coral recruitment surveys
  - Quadrat photos and surveys
  - Coral transplant assessment
  - Settlement plate collection
  - Artificial substrate pad collection

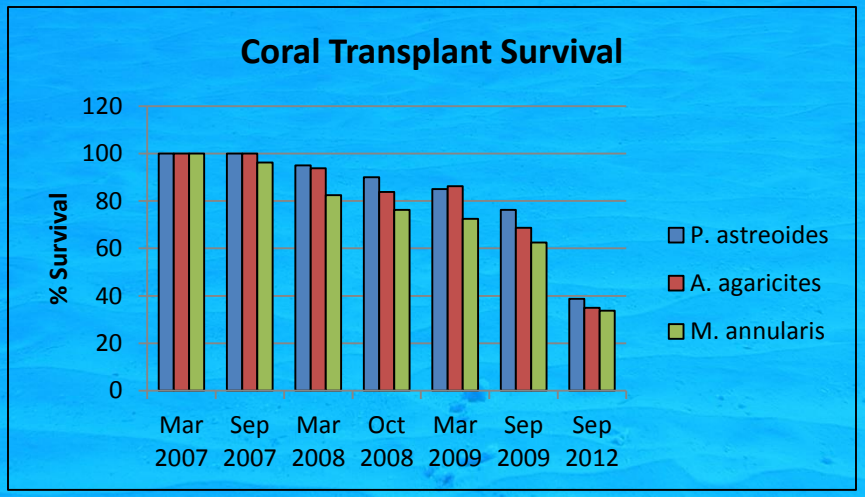




Coral, Benthic Invertebrate and Macroalgal Assemblages

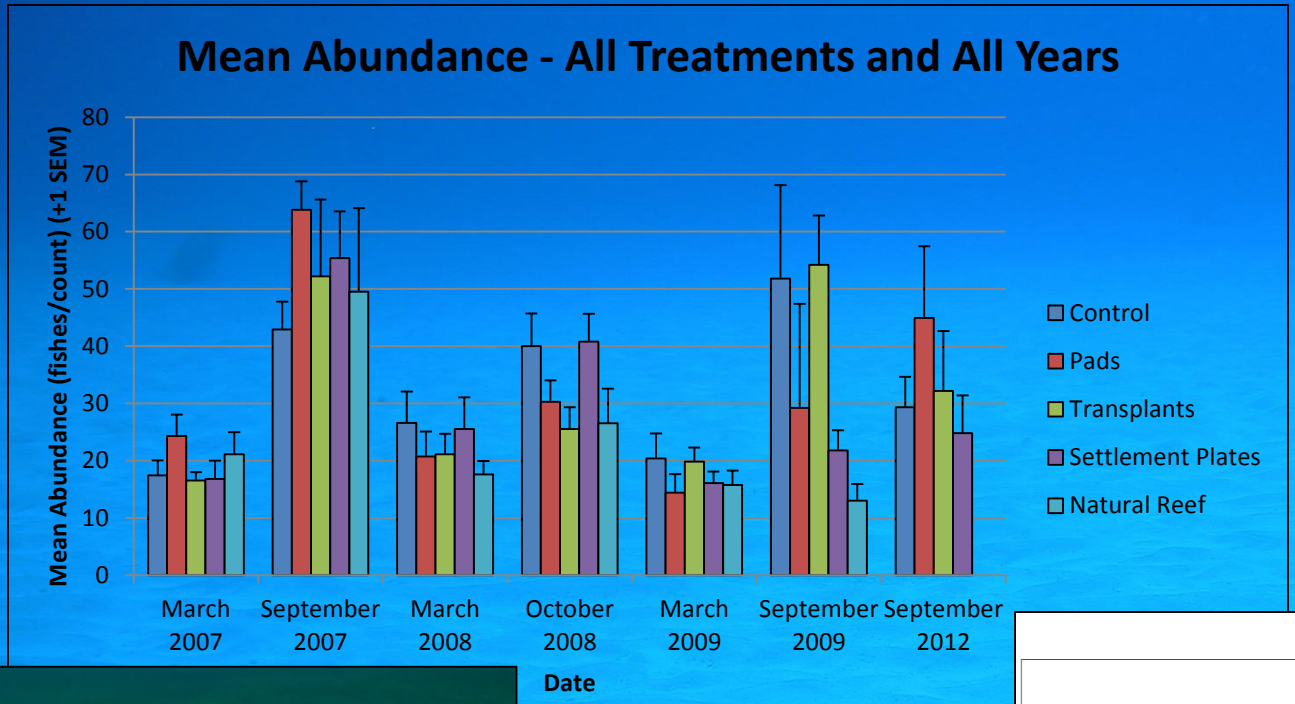




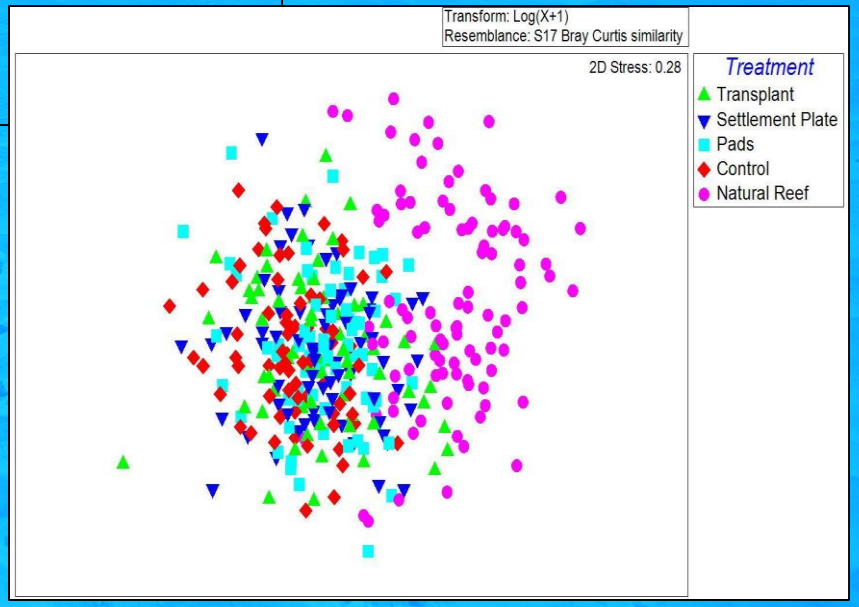


- **Increased coverage by benthic inverts and macroalgae**
  = decreased area available for settlement and growth of coral recruits
- **Pad material seemed to accelerate growth of *Desmapsamma anchorata*, which inhibited coral recruitment and survival of coral transplants**

Results: Reef Fish Assemblages



- Seasonal fluctuations
- No significant diff. in abundance or species richness between treatments
- Subtle species-specific differences
- Assemblages on ARs and NR dissimilar



- Benthic fouling community may have homogenized the treatments from a fish's perspective to some degree

Summary and Conclusions

- **Was intervention justified?** Not according to the goals of this project.
- **Would a more structurally complex coral transplant species (i.e., *Acropora cervicornis*) have produced a more abundant and diverse assemblage of reef fish?** Perhaps, but results suggest that the sponge would have overwhelmed it too. Routine maintenance would help!
- **Did any treatments produce fish assemblages similar to nearby natural reefs?** No, or at least not yet.
- **Addition of final 'bonus' data collection point (6 years post deployment) indicates continued changes in community structure.**
- **Highlights the importance of using** long-term monitoring for assessing AR performance**, and** pilot studies **prior to implementing large scale restoration projects.**
- **Idea for consideration:**
  Transplant corals after initial wave of rapidly growing benthic organisms reaches a functional state of equilibrium.