

Restoring Reef Ecosystem Health



Ideas for restoring key functions through management interventions



Healthy Reefs
for healthy people

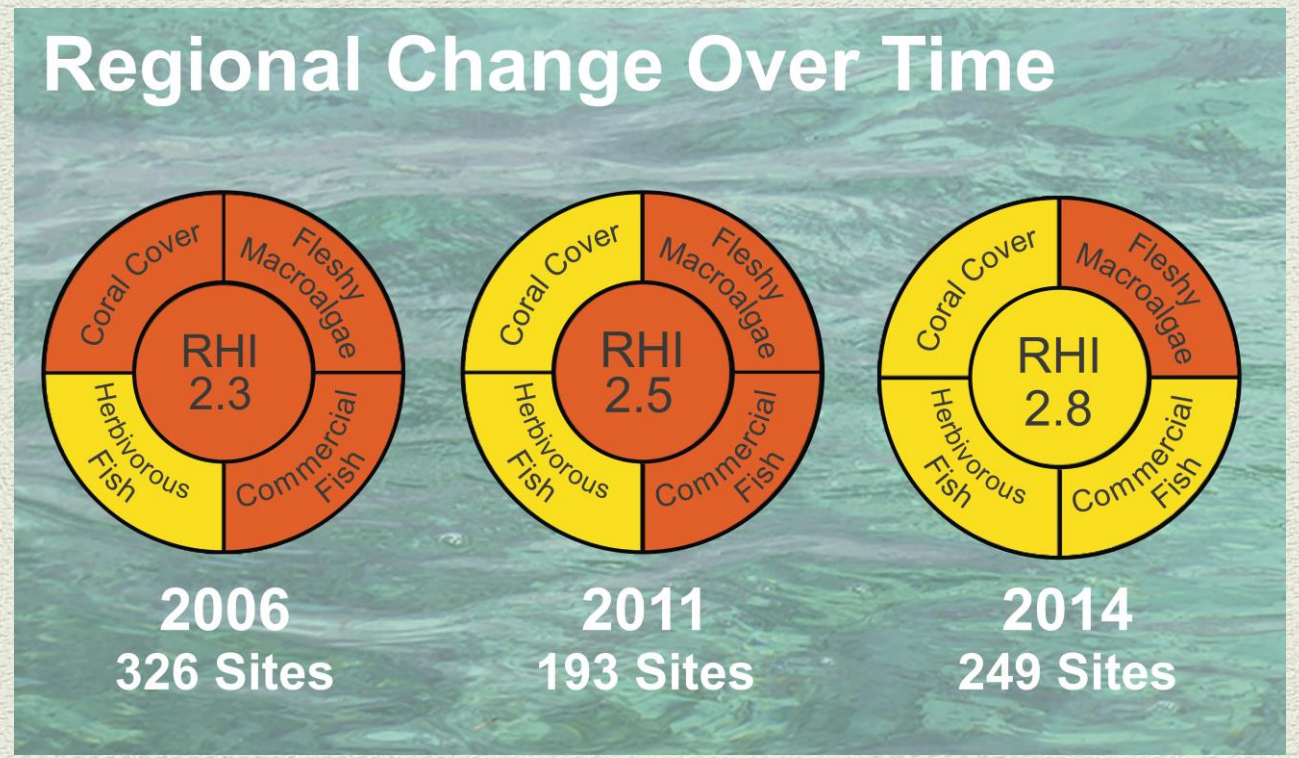
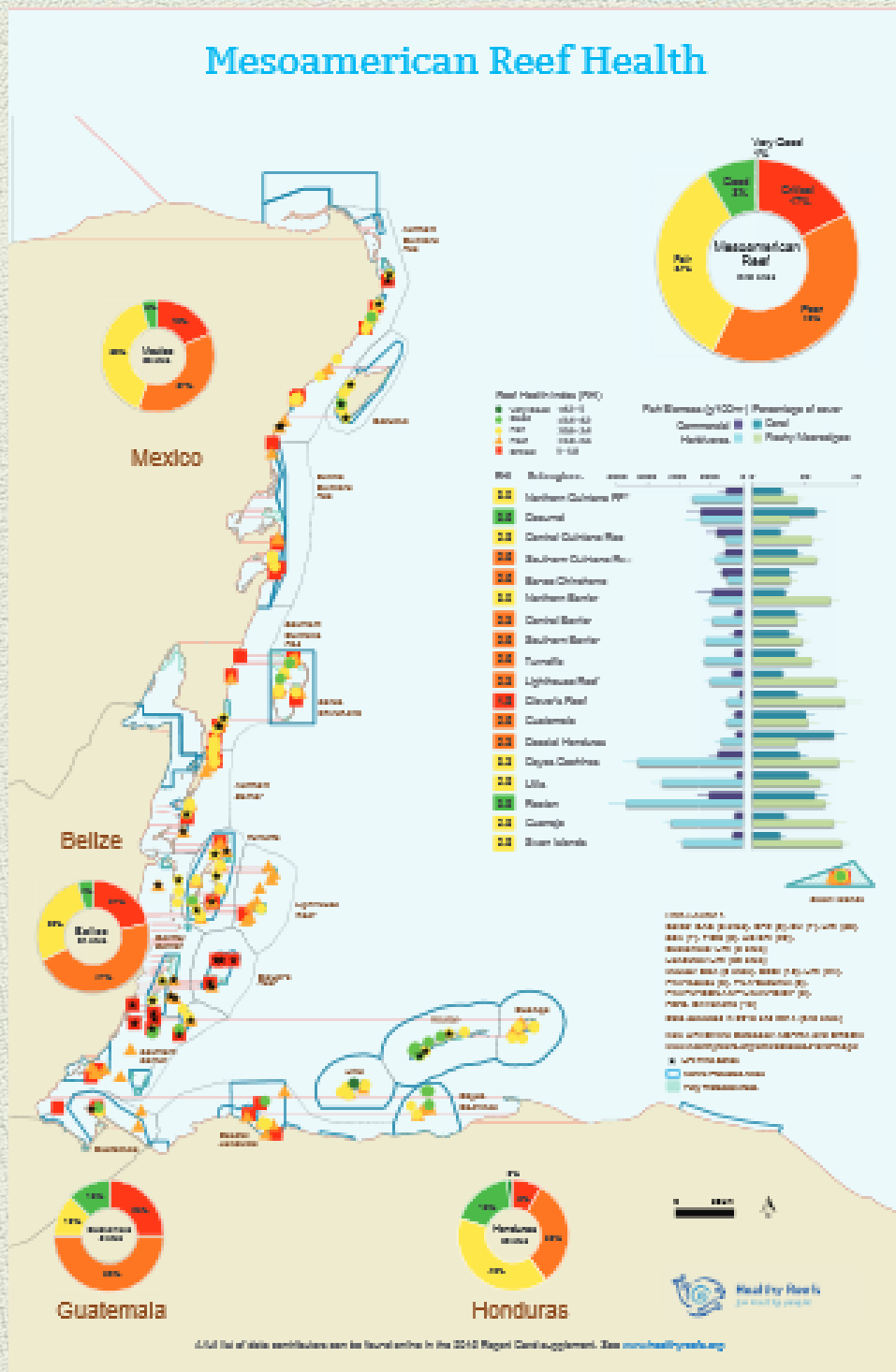
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**Smithsonian
Institution**

We Need Restoration Because Many Reefs Are Not Healthy



2015 Mesoamerican Reef Report Card

But we need to know if restoration sites suffer from chronic stress, or acute disturbance events. Reefs with high chronic stress may not be restorable.

HRI'S ADAPTIVE MANAGEMENT CYCLE

Reef Monitoring & Database

Standardized protocols, training, online database

Reef Report Cards

Evaluate Reef Condition
Make Management
Recommendations

Eco-Audits

Evaluate Implementation
of Recommendations

Wise and
frequent use of
media

Improved
Policies &
management
= Improved
reef health

All steps
implemented
with the
collaboration &
participation of
partner
organizations

When we think of coral restoration we normally think of this:

**>90,000 corals planted
>35% increase in coral cover**

This is fantastic and needed but we also need to think about the larger reef ecosystem and its functioning

Restoring Ecosystem Functions

We need to expand our view of restoration to encompass key functions, including:

Herbivory:

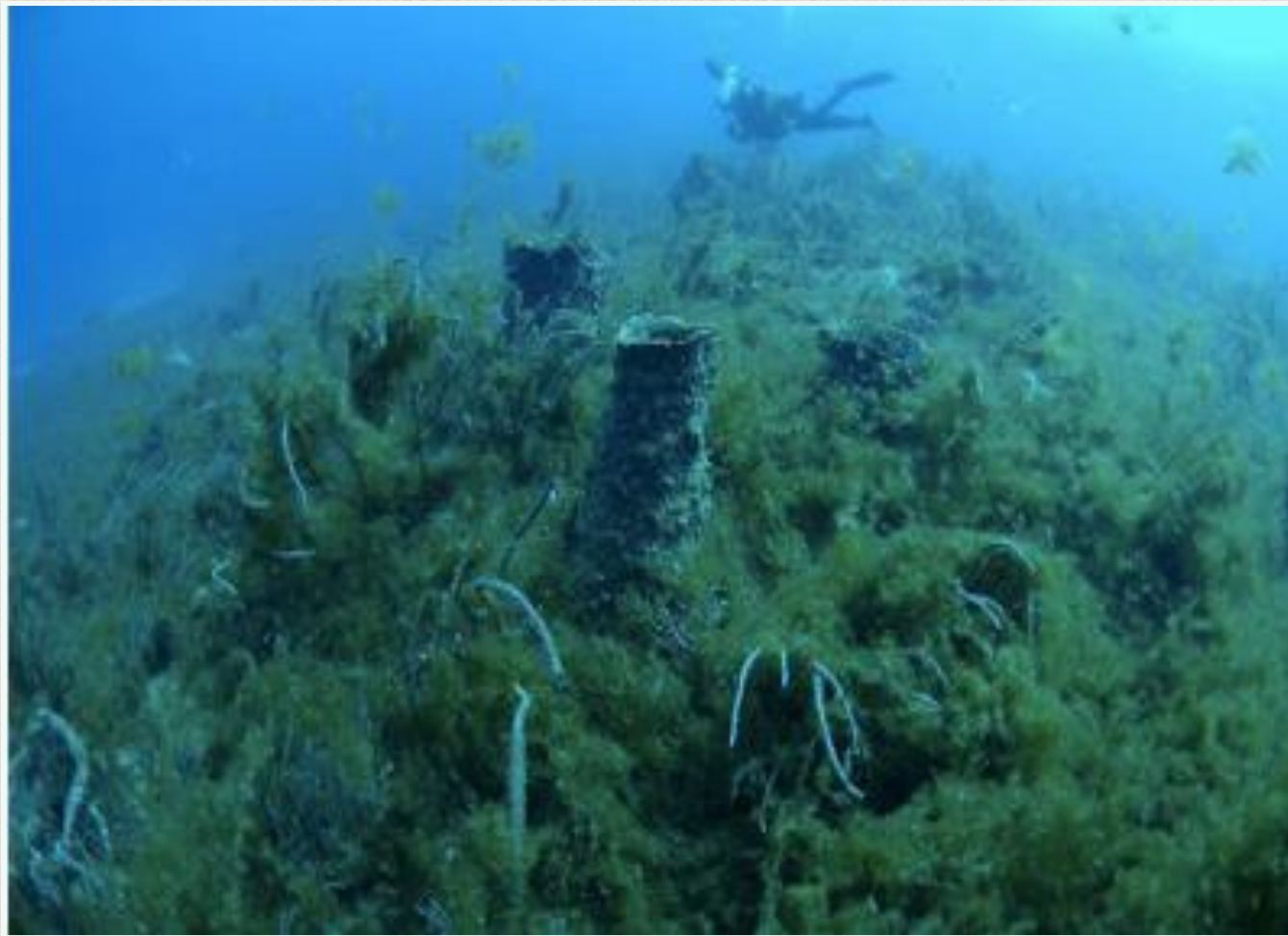
- ◆ *Diadema*
- ◆ King Crab
- ◆ Reef Weeding

Filtration - Natural Water Cleansing & Shoreline Protection:

- ◆ Red Mangrove
- ◆ Seagrass
- ◆ Sponges



Macroalgae is a Menace

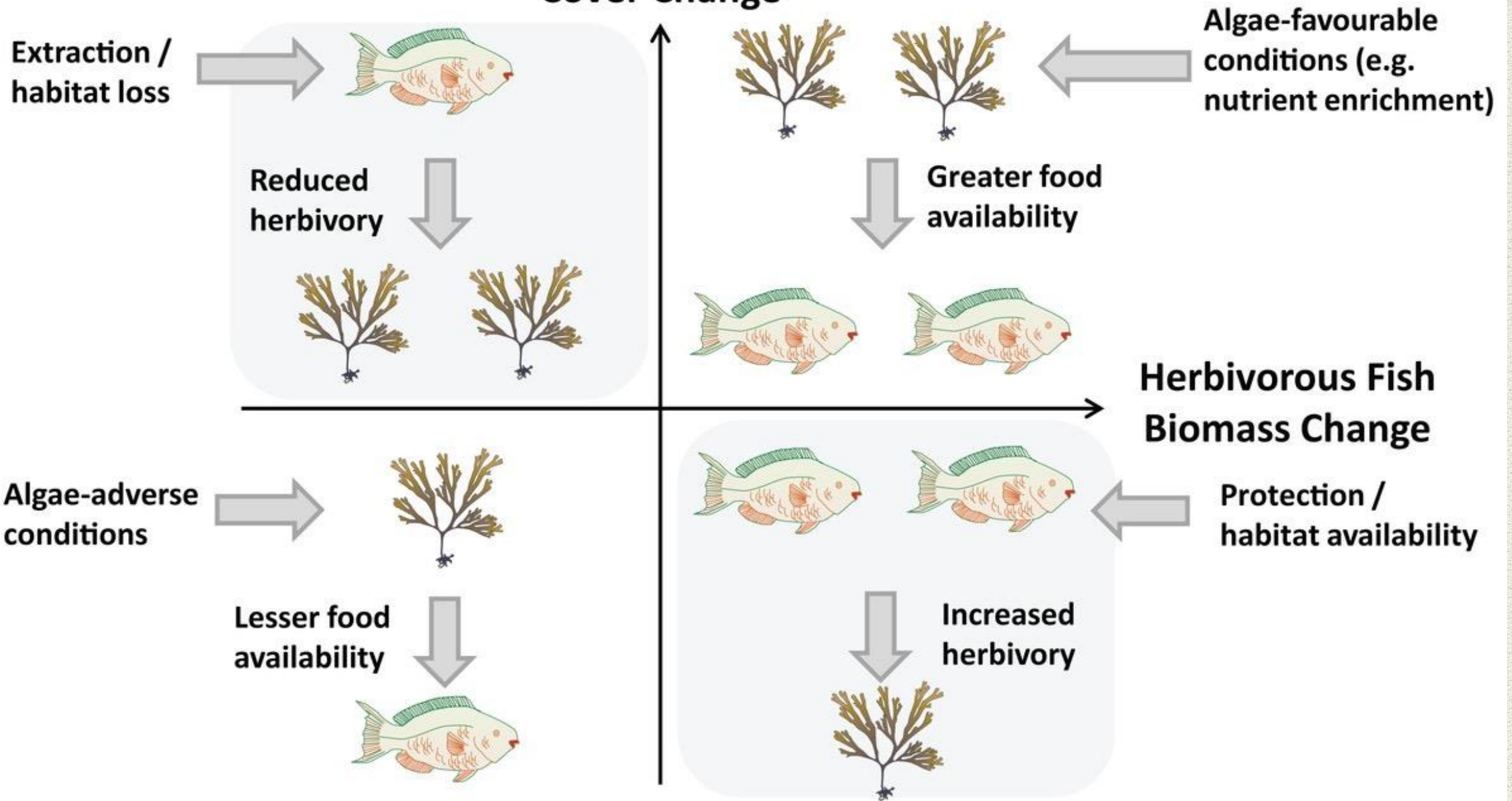


Magroalgal Massacre

We need to reduce nutrient pollution from sewage, agricultural and industrial run-off.

But we can also restore natural levels of herbivory by restoring key herbivores back to the reef, and manually jumpstarting recovery by weeding/removing key reefs of macroalgae.

Fleshy Macroalgal Cover Change



Rapidly increasing macroalgal cover not related to herbivorous fishes on Mesoamerican reefs

Conservation Biology Ecology Marine Biology

Adam Suchley^{1,2}, Melanie D. McField³, Lorenzo Alvarez-Filip²

Published May 31, 2016 PubMed 27280075

3-4 Prong Strategy to Restore Herbivory (concurrent with nutrient reduction strategies)

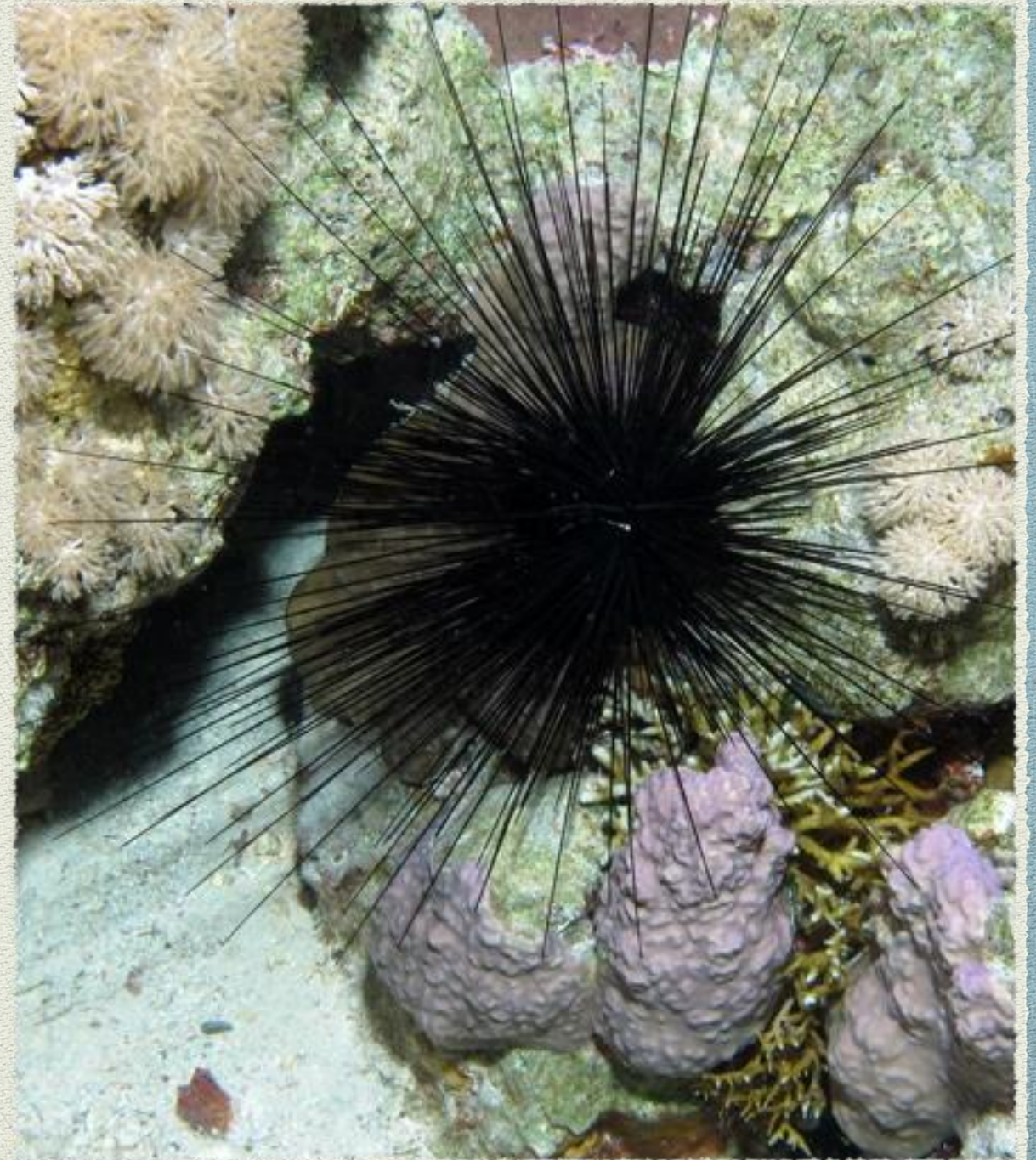
- ◆ Restoring herbivory through parrotfish protection (a management intervention designed to restore herbivory)
- ◆ Facilitate recovery of *Diadema* and possibly King Crab, through enhancing recruitment or lab rearing and restocking on the reef
- ◆ Jump-start key reefs by priming them through Reef Weeding: algal removal efforts



Ken Marks

Restoring *Diadema* for cleaner reefs

- ◆ Natural recruitment seems to be linked to areas of high reef relief. Not necessarily the same areas where you find high density of adults.
- ◆ Simple methods for measuring recruitment: maybe it can be enhanced or facilitated.
- ◆ More complex methods of rearing them to 3-4 cm size for release into caged plots on the reef, to grow in size. After 2 months they are home and stay there cleaning the reef.
 - ◆ Stacey Williams, Puerto Rico.
 - ◆ www.youtube.com/watch?v=dJVPErvMTCI



Caribbean King Crab

serious herbivore - delicious dish

- *Maguimithrax spinosissimus*
 - can grow up to 3kg
- Mariculture options studied since the early 1980's, including case culture with algal screens
- http://aquaticcommons.org/12559/1/gcfi_39-49.pdf
- Aquaculture income could sustain restoration efforts (or private companies required to give 20% production for reef conservation)



Fragments of Hope has proposed a baseline study in S. Belize

Biodiversity: crustaceans



Domecia acanthopora



Mithrax cinctimanus



M. sculptus



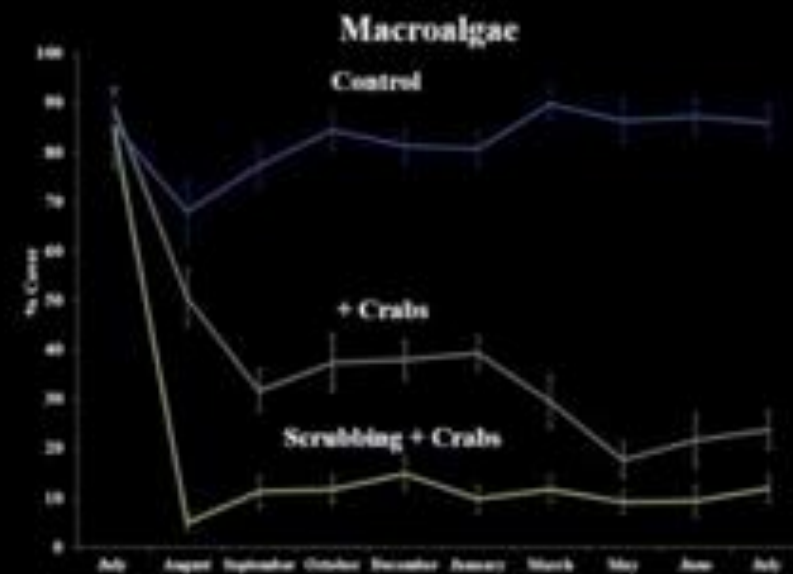
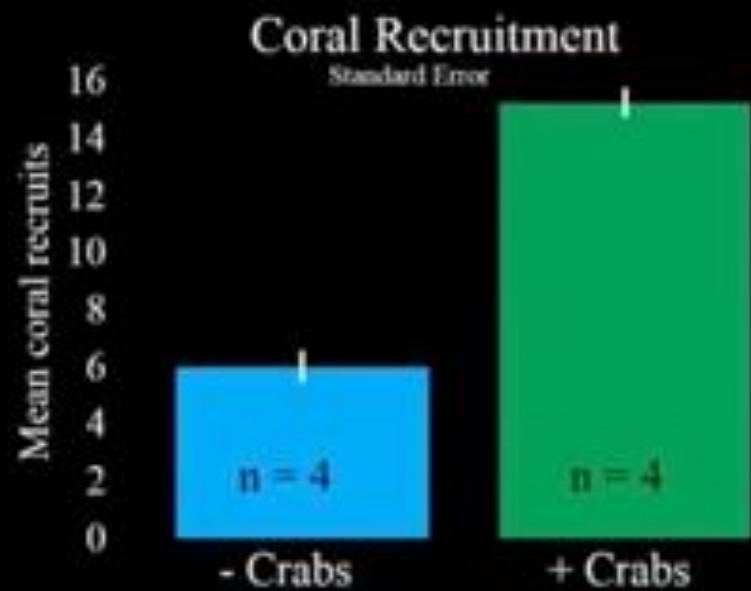
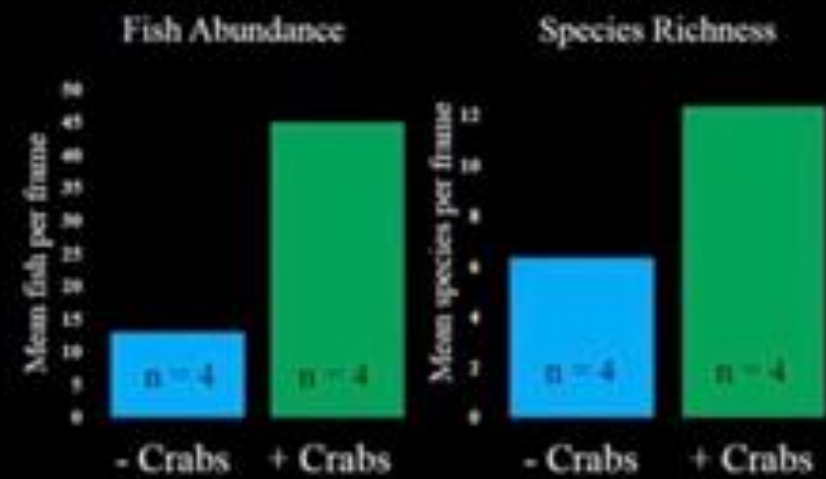
Paguristes puncticeps ?



M. spinosissimus



Lisa Carne - FoH



Crabs love shades, too. Plus corals recruit to shades, and we can plant corals on shades-shades can be used as seaweed farm anchors, crabs eat seaweed...



Humans as Reef Weeders

- ◆ Reef recovery can get a jump start from direct macroalgal reduction by human weeding:
 - ◆ 2.5 kg/m² removed with hedge clippers and wire brushes from 8 patch reefs in 1998-99.
- ◆ Responses of algae, corals and fish to the reduction of macroalgae in fished and unfished patch reefs of Glovers Reef Atoll, Belize.
 - ◆ Coral Reefs (2001) 2001, Volume 19, Issue 4, pp 367–379. T. McClanahan, M. McField, M. Huitric, K. Bergman, E. Sala, M. Nyström, I. Nordemar, T. Elfwing, N. Muthiga.
- ◆ We suggest that reducing macroalgae, as a technique to restore turf and encrusting coralline algae and stony corals, may work best after reefs have been fully protected from fishing for a period long enough to allow herbivorous fish to recover (i.e. >5 years).

Heroes of Herbivory



Restore balanced herbivory with a jump start of immediate macroalgal reduction by humans if needed.
It's time for careful pilot studies in order to gauge success.

Other Ideas Include Restoring Natural Filtration & Shoreline Protection

- **Sponges** - Review from CRTF
- **Seagrass** - Are there any projects in the MAR? What success stories can we follow?
- **Red Mangroves** - Make an inventory of past & current projects, acres planted, techniques, etc. What about trying to restore prop root communities on mature stands?



Restoring Sponge Populations

- ◆ Sponges are critical for water filtration, removing nutrients, bacteria & sediments; increasing fish, enhancing soundscapes, and fixing Nitrogen
- ◆ Several successful examples of pilot work in Florida
 - ◆ Mark Butler
www.odu.edu/directory/people/m/mbutler
 - ◆ <https://www.youtube.com/watch?v=nzmAsjEzccE>



Large and Small Scale Impacts of Restoration Need to be Monitored

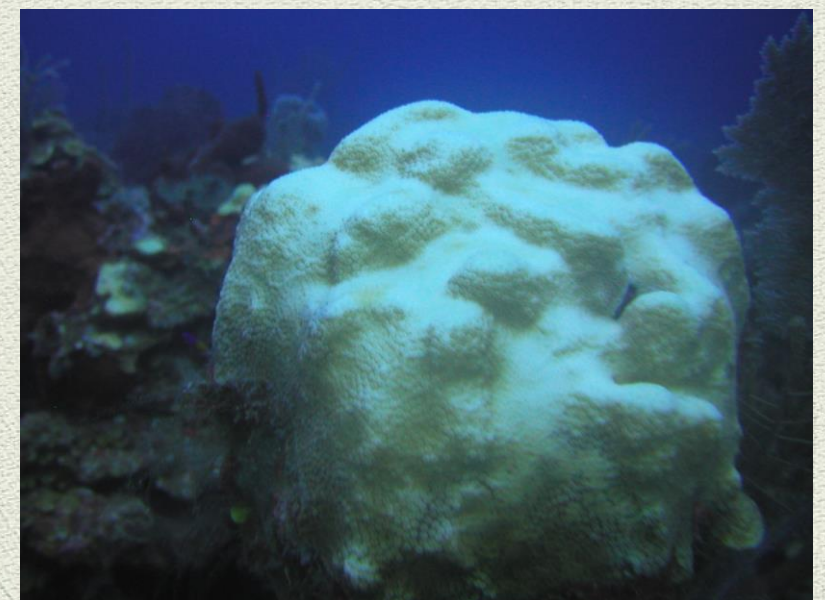
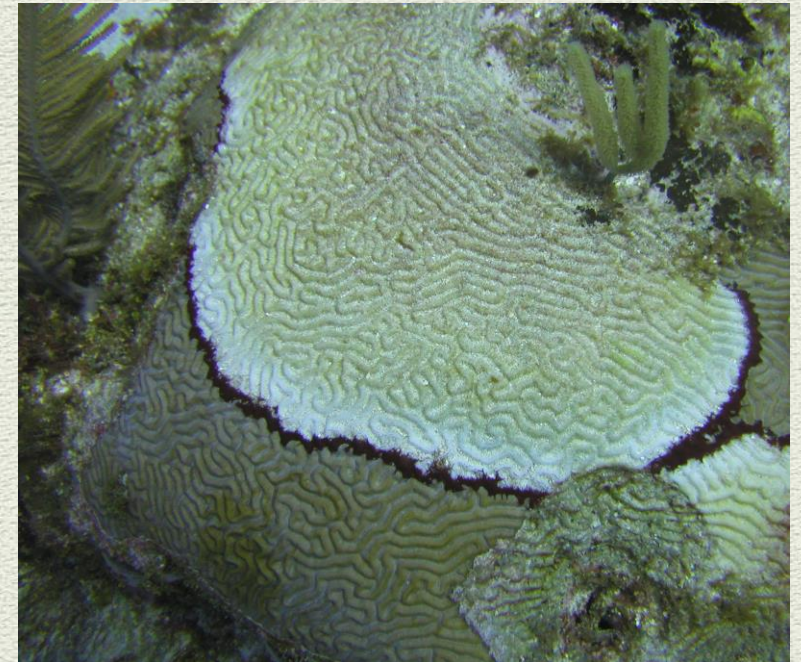
- Healthy Reefs Database provides some context
- If more partners would use the database to store, analyze and share their data, it would be a more powerful resource
- A suite of additional methodologies evaluating specific restoration techniques should be developed and shared
- We could expand our database to accommodate this and more



Early Timeline of Major Reef Disturbances

it matters where we choose to restore

- ◆ 1973-74: Black band disease makes its appearance in the Caribbean.
- ◆ 1978-79: Staghorn and elkhorn corals suffer die-off in Florida.
- ◆ 1980-81: Staghorn and elkhorn corals die in Jamaica.
- ◆ 1982-83: Staghorn and elkhorn corals die throughout the Caribbean (major El Niño).
- ◆ Sea urchin *Diadema*, a key reef herbivore, dies throughout the Caribbean, allowing algal infestation of dead corals.
- ◆ 1985-87: Black band disease rampant in Florida.
- ◆ Corals bleach throughout the Caribbean and seas grasses die in Florida (major El Niño).
- ◆ 1990 & 1994: Corals bleach in Florida.
- ◆ 1995: Corals bleach in MAR
- ◆ 1998: Corals bleach throughout the Caribbean (major El Niño).





If we could agree to collaborate on different structural & functional elements in a few places in the MAR, we could be the first place to rebuild the holistic ecosystem and likely gain important new insights & management recommendations



Restoration is one tool of Management

Restore key structural & functional attributes of healthy reefs requires a multi-pronged approach, with this as one key element, alongside efforts to reduce sources of stress.