UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL of MARINE, ATMOSPHERIC & EARTH SCIENCE

Spatial Patterns of Bleaching and Growth in *Acropora palmata*

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Introduction

•Coral reefs harbor 25% of marine biodiversity and provide crucial economic benefits

•Biological and physical stressors (e.g., high temperature, eutrophication, diseases) have caused global coral declines

•Locally, anthropogenic stressors have amplified global declines

•Coral reefs in the Miami area are commonly exposed to high levels of turbidity and nutrients

•However, recent surveys have found surprisingly healthy coral communities along highly urbanized seawalls

•This study examines the response of *Acropora palmata* (elkhorn coral) to urban reef conditions to determine whether these unusual environment can support the growth of this threatened species and to understand the drivers of coral survivorship and growth between different environments

•If corals can be grown effectively in nearshore coral nurseries, this could reduce propagation costs. Additionally, corals grown in marginal nearshore habitats may have higher resilience once transplanted offshore

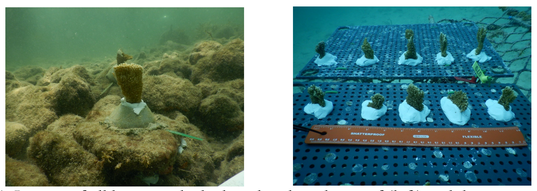

Fig. 1. Images of elkhorn corals deployed at the urban reef (left) and the nursery (right).

Methods

• *Acropora palmata* fragments (4.3 ± 1.2 cm in diam) from 5 genotypes (n = 10 per genotype) were collected from an offshore coral nursery and divided into 2 groups

•Smaller fragments (n = 5 per genotype) were collected and preserved for "initial" lipid analysis

•Fragments (n = 5 per genotype per site) were deployed at: 1) a rubble field near a seawall at the Port of Miami ("urban reef", depth = 2 m) and 2) at the UM nursery ("nursery", depth = 8m) on August 11th and monitored monthly until March 2023

•During each survey, the health (alive/dead, coloration, bleaching status) of each fragment and its size were assessed

•Temperature patterns were measured at or near each site using HOBO loggers

•Small tissue samples were collected from surviving fragments (n=10 at the nursery; n=12 at the urban reef) at the end of the study for lipid analyses

•Differences in condition, growth, and lipid levels were compared between sites

Hypothesis

Corals planted onto an urban reef will experience higher levels of mortality and reduced growth compared to offshore habitats

Results

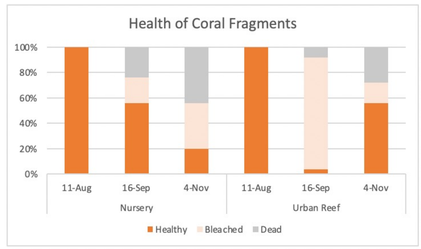

Fig. 2. Proportion of coral fragments showing different health values. There were significant differences between the. proportion of bleached corals as both sites in September and November ($p < 0.05$, Chi-square Test).

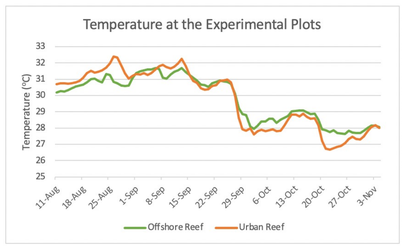

Fig. 3. Temperature at both the urban reef and an offshore reef near the nursery were collected by HOBO logger.

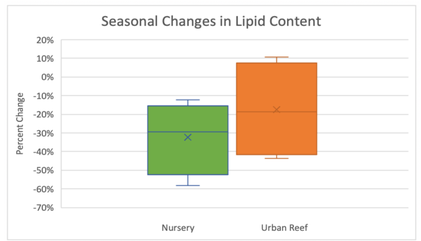

Fig. 4. Percent change from initial lipid levels (0.74mg/cm^2) to final lipid levels and the nursery (mean = -32.5%) and urban reef (-17.5%). The decline at the nursery was significantly lower ($p < 0.05$) but decline at the urban reef was not significant ($p > 0.05$).

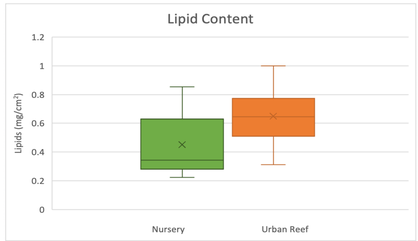

Fig. 5. Mean total lipid content seven months after out planting at the Nursery (0.54 mg/cm^2) and the urban reef (0.65 mg/cm^2). The urban reef had significantly higher lipid levels ($p < 0.05$, Mann Whitney U test).

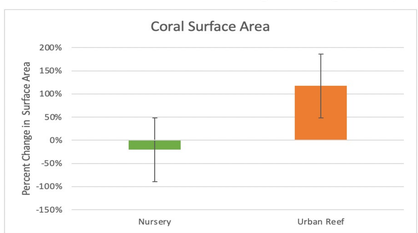

Fig. 6. Average change in surface area of surviving fragments over the duration of the study at the nursery (-20.5%) and the urban reef (117%). Differences in surface area were significant between sites ($p < 0.05$, Mann Whitney U test).

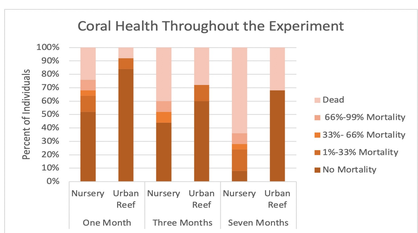

Fig. 7. After seven months, the urban reef suffered less mortality. The proportions of the two sites were only significantly different at the seven-month time point ($p < 0.05$, Chi-square Test).

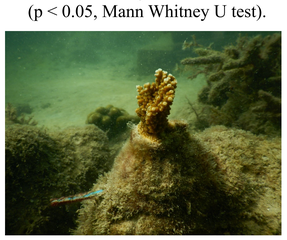

Fig. 8. Images of healthy and bleached corals at the urban reef taken November 4th 2022.

Key Findings

•The summer of 2022 experienced a high temperature anomaly and bleaching was observed in transplanted and wild corals, with 48 days with temperature > 30°C at the nursery, and 55 days >30°C at the urban reef (**Fig. 3**)

•The offshore reef near the nursery had slightly lower mean temperature (29.79°C) than the urban reef (29.84°C) over the course of the experiment (**Fig. 3**)

•While bleaching prevalence was higher at the urban reef, coral mortality was higher at the nursery (**Fig. 2**)

•The corals at the nursery and the urban reef decreased their lipid levels over the seven months they were monitored, likely due to seasonal trends. The declines in lipid content were higher at the nursery compared to the urban site (**Fig. 4**)

•For surviving fragments, lipid levels were significantly higher at the urban reef than at the nursery after seven months (**Fig. 5**)

• For surviving fragments, the urban reef had significantly higher growth rates than the nursery (**Fig. 6**)

•Overall condition was better at the urban reef when compared to the nursery (**Fig. 7**)

Discussion

- Urban environments proved to be a good habitat for transplanting corals of the threatened coral species *A. palmata* in the absence of unusually high temperatures
- During the bleaching anomaly, corals on the urban reef had higher bleaching prevalence
- However, corals at the urban reef showed lower mortality and higher bleaching recovery compared to the nursery site at the end of the study
- Corals on the urban reef showed higher lipid content at the end of the study, likely due to higher heterotrophy levels in the urban environment
- Higher lipid content in urban corals can, at least partly, explain the higher survivorship and bleaching recovery observed compared to the nursery
- Urban, nearshore environments can be good locations for growing and "fattening" corals during non-bleaching periods but corals need to be removed from these environments prior to the onset of bleaching

Future Directions

- The role of stress hardening on inshore corals should be further evaluated, as non-lethal stress may lead to increase resilience
- The combination of increased heterotrophy and stress-hardening must be better understood and could have important restoration implications that require further investigation.

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