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Using multielement-isotope coral paleothermometry to reconstruct the thermal history of seawater across a Caribbean barrier reef system over the past century and evaluation of its impact on coral extension rates

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Abstract: Coral coverage throughout the world has declined by more than 50% over the past 100 years. This decline has been attributed to a variety of anthropogenic stressors including pollution, overfishing, ocean acidification, and global warming. The Caribbean Mesoamerican Barrier Reef System (MBRS), which extends along much of the eastern seaboard of Honduras, Belize, and Mexico, has been negatively impacted by these anthropogenic stressors, with some regions of the reef system experiencing greater than 80% coral loss. Experiments suggest that elevations in seawater temperature of 2-3 ºC over the past century, driven by CO2-induced global warming, are largely responsible for these extreme reductions in coral cover. Furthermore, temperatures are predicted to rise by another 3-5 ºC over the next century, posing even greater threats to the MBRS and other reef systems around the world. Ries and Castillo propose to investigate the relationship between seawater temperature and coral extension rates in the MBRS by investigating the following questions: *(1) How has seawater temperature at inner reef, backreef, and forereef localities of the MBRS varied over the last 100 years? (2) How have these changes in seawater temperature influenced rates of coral extension in these three zones of the MBRS? (3) Does the relationship between seawater temperature and coral extension rate vary amongst these three zones of the MBRS?* Last year, the PIs obtained thirteen cores from the reef-building coral *Siderastrea siderea* at nearshore, backreef, and forereef sites across the MBRS, which each record between 75 and 100 years of growth.

Measurement of annual growth bands within these corals reveals that their rates of linear extension have steadily declined over this interval in the nearshore and forereef sites, but have increased in the backreef site. Ries and Castillo propose to use in situ temperature data collected with high resolution temperature loggers at their three study sites between 2002 and 2009 to calibrate a multi-proxy (Sr/Ca, Mg/Ca, U/Ca, δ18O) coral paleothermometer based upon their 13 existing and 17 proposed additional cores. Approximately 100-year seawater temperature records would then be reconstructed for their three study sites from Sr/Ca, Mg/Ca, U/Ca, and δ18O data obtained from the 30 cores. These site-specific seawater temperature records would elucidate how global-scale warming is manifest across local reef environments. Comparison of in situ temperature records with skeletal extension data obtained from X-radiographs of the cores would constrain the relationship between rising seawater temperatures and coral health and reveal how this relationship varies across a barrier reef system. Critically, the proposed work would generate a statistically robust multi-proxy coral paleothermometer that could be applied to other regions and across longer timescales, and which could potentially be recalibrated for other coral species. BROADER IMPACTS: The results of proposed research would be archived in the NOAA Paleoclimatology Program data repository and would inform local, federal, and international climate change legislation and policy. PI Ries is a new faculty member whose developing research program would be materially enhanced by the activities described within this proposal. The proposed research would also support the professional development of co-PI Castillo, an early career minority scientist poised for a promising career in the marine sciences