# THE REEFS TOMORROW INITIATIVE

## Summary

Around the world, the health of coral reefs is threatened by numerous factors including increasing temperatures, overfishing, pollution, and sedimentation. Despite these threats, some reefs show remarkable resiliency and are thriving. The Reefs Tomorrow Initiative is a collaboration among scientists from academic institutions and conservation organizations who are using computer models and field studies to investigate how healthy reefs respond to multiple and simultaneous threats. In parallel with our research efforts, we are working closely with managers to use our improved understanding of how reefs function to build tools that reef stewards can use to evaluate trade-off decisions and restore reef resiliency.

*Program Outcome:* One of the key unanswered questions in coral reef science today is addressed: how is reef resilience affected by interacting environmental conditions? For the first time, reef managers and conservation professionals will have the information they need to make empirically-based tradeoff decisions.

To accomplish our Program Outcome, we are pursuing a two-phased, multi-disciplinary, multi-institutional, and multi-site research initiative for five years to answer fundamental research questions and apply the findings to active management of coral reef ecosystems. We launched the first phase of our work in August 2012 with initial funding from the Gordon and Betty Moore Foundation. In this first phase, we are developing a novel reef resilience model – based on synthesis of existing data, and targeted new observations, and informed by a systematic analysis of management and conservation needs – to fill a critical gap in coral reef science while laying the groundwork for future application to conservation and management.

## Background

Coral reefs have been called an ecological canary in the coalmine due to their sensitivity to a suite of anthropogenic impacts, including overfishing, pollution, acidification, and climate change. These stressors interact in different ways on coral reefs around the globe, creating site-specific impacts that erode ecosystem function. While observations of declining coral reef health are widespread, some reefs have fared reasonably well even in the face of environmental disturbance. Increasingly, scientists are pointing to the concept of ecological resilience to explain these different outcomes. Resilience is the ability of a system to either retain or recover to a particular state following a disturbance. But reef resilience science is in its infancy, and a lack of knowledge limits the practical implementation of the concept in management and conservation.

Importantly, we lack the scientific tools to measure coral reef resilience, especially when many stressors affect the reef at the same time. Without the ability to measure resilience, the scientific community is unable to give managers and conservation practitioners empirically-driven advice about the relative merits of alternative management interventions. In other words, until scientists can describe what it will take for reefs to remain resilient, their advice will not be any better than, *"herbivorous fish are good for reefs, and nutrient pollution is bad for reefs."* Yet real world management questions are more nuanced and often involve tradeoffs: how many herbivores are needed? How much nutrient pollution can a reef take? Should management focus on overfishing or coastal development? And, can local conservation offset or limit the effects of climate change? Current attempts to answer these questions add up to little more than educated guesswork.

## Program Plan

Our mission is to advance coral reef science, management, and conservation through interdisciplinary study of reef resilience, and to work with managers to apply this new understanding to reef conservation. In practice, this involves a tight coupling of empirical research, theoretical modeling, and applied conservation.

To advance resilience science, we have launched an ambitious, multi-phase, interdisciplinary program to measure and model resilience. We have begun our work at Palmyra Atoll in the central Pacific Ocean, whose remote location and lack of human inhabitants makes it an ideal location to explore pristine ecosystem function. We are taking advantage of existing gradients of coral reef condition at Palmyra Atoll to examine how suites of forcings—biological or physical factors that can make an environment more or less hospitable—combine to yield ecological outcomes. To organize and synthesize these data and to identify empirical measures of reef resilience, we are developing a new suite of mathematical models. In future work, we plan to use manipulative experiments at Palmyra Atoll to extend natural gradients, and to expand our work to other geographies across the Pacific Ocean.

To ensure that our work addresses the most pressing applied information needs we are actively engaging with resource managers across the Pacific. We began this process by completing a systematic survey of the information needs of reef managers and conservation professionals, and have used this information to revise our ecological modeling and data collection efforts to ensure that they are aligned with management and conservation priorities. We have also built partnerships with on-the-ground practitioners who are integrally involved in shaping our modeling inputs and outputs. Based in places such as Fiji, the Solomon Islands, and Palau, these partners are in a position to directly apply resilience science to management and conservation decisions. In the future, we will work with our partners to build, test, and refine a scenarios tool to evaluate trade-off decisions in a changing climate.

Throughout Phase I, we are seeking additional resources to launch Phase II, which will add new program elements focusing on experimental manipulations, expanded geographic scope of data collection, refined models, and tools that effectively communicate scientific findings for use in applied conservation and management. By the end of Phase II, we will have measured and modeled aspects of ecological resilience on Pacific coral reefs, while offering concrete guidance to enable and enhance reef management and conservation.

## Key Partners

The Reefs Tomorrow Initiative is a collaboration between experts at a suite of world-class research institutions and conservation organizations, who collectively contribute a broad range of skills and knowledge to this multi-disciplinary project. Current members of the Reefs Tomorrow Initiative include the American Museum of Natural History, the Coral Reef Alliance, The Nature Conservancy, Scripps Institution of Oceanography, Stanford University, University of California Santa Barbara, University of North Carolina Wilmington, and Victoria University of Wellington. For more information about the Reefs Tomorrow Initiative, please feel free to contact Program Director Dr. Madhavi Colton at mcolton@coral.org, or visit our website at www.reefstomorrowinitiative.org.