CONFERENCES & WORKSHOPS

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Caribbean Coral Reefs at Risk

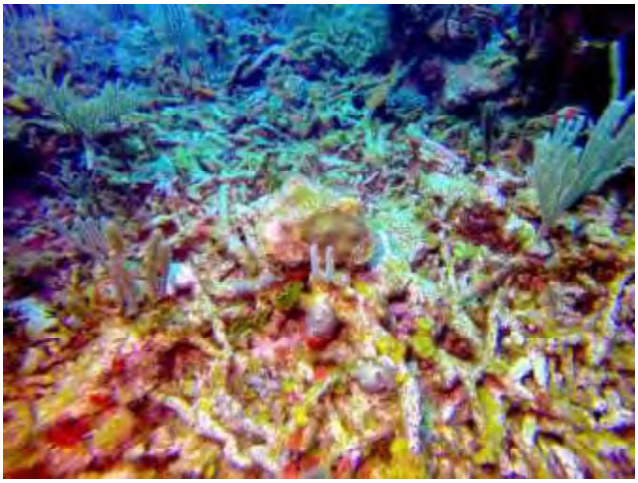
Improved Decision Making Through Better Science and Communication

Group Statement from the Workshop held at the Teresa Lozano Long Institute of Latin American Studies, The University of Texas at Austin, September 2015

The degradation of Earth's coral reef ecosystems has environmental and socio-economic consequences of importance to fisheries, food security, shoreline stability, tourism, and economic development options. Since our planet's history suggests that thousands to millions of years have been necessary for coral reefs to recover from similar past collapses, a key question that deserves an immediate response is '*Can we afford further degradation*?'

Coral reef ecosystems in the Caribbean are particularly at risk. The well-documented loss of coral cover throughout the region, and the increased abundance of macroalgae in many locations provide strong evidence of systems undergoing major changes in species composition, physical structure, and function. The causes of modern coral reef degradation are numerous and can differ from one location to the next, but experts agree that humans have played and continue to play a major role in this decline.

As concerned citizens representing a variety of geographical locales from both the private and public sectors, the participants of The University of Texas workshop held in September 2015 wish to voice our concerns and recommendations for how to proceed with the conservation of coral reefs and other associated coastal environments. Although we acknowledge the alignment of our views with statements and resolutions of the US Coral Reef Task Force, we still wish to reformulate and emphasize some important points. As a group we concluded that the main challenge we face is determining how to bring the best science and management actions together to assist in ecosystem recovery. We believe this would be best achieved through the regional replication of locally implemented management measures that take advantage of the natural resilient capabilities of coral reefs. Workshop participants from Colombia, México, Puerto Rico, and the U.S. Virgin Islands concluded that warmer seawater temperatures, particularly by rendering susceptibility to disease outbreaks, and land-based sources of pollution represent two of the most pressing causes for coral reef degradation in each of these areas. Participants agreed that Caribbean-wide reductions of some key coral reef stressors can be achieved through local actions and watershed-scale management efforts.



Degraded reef in Akumal-MX (Photo by JR Garza-Pérez)

What are the causes of coral reef degradation?

- ***Regional or global causes*** – While climate change can induce severe stress to coral reef systems through warming seawater temperatures and acidification, little can be achieved at a local level to directly attenuate those sources of stress. However, it is still possible and worthwhile to control and manage local stressors. Climate change must not be used as an excuse to stall local actions.

Coral Bay, St. John, US Virgin Islands (Photo by Judy Scott, CBCC)

- ***Local causes*** –Intensive fishing and water quality deterioration associated with land development are two very important and potentially controllable local sources of stress [*See Akumal-México inset*]. By mitigating these effects, we may allow corals enough time to adapt to a changing climate and resist other sources of stress such as those related to disease. The recently published Caribbean-wide coral reef synthesis by Jackson et al. (2014)[1] focuses on overfishing of parrotfish (*Scaridae*) as a major cause of reef decline in the Caribbean, but the case studies presented at The University of Texas meeting identified watershed-based pollutants, as well as coral bleaching and diseases associated with elevated seawater temperatures as the primary concerns. We do not believe it is necessary to identify a single cause for the degradation before taking action---in fact, it is misleading given the expected variability in coral reef resiliency at the species and ecosystem levels, the spatial heterogeneity of each type of stressor, and the synergistic effects of combined stressors.

What if we just sit and wait?

- ***Can reefs adapt?*** **–** Degradation is often interpreted as a sign of the inability of ecosystems to adapt to unprecedented environmental change. If unchecked, ongoing regional trends in stressors linked to climate change, population growth, fishing, and land development will continue to accentuate the differences between the conditions in which corals and associated ecosystems thrive and those imposed by humans.
- ***Giving them a chance*** – The fossil reef record tells a formidable tale of reef collapse and recovery. The recent rate at which we have imposed changes on coral reefs and associated ecosystems is unprecedented in the current geologic era and the result has been the mortality of corals with adverse effects on fishes and other reef organisms. By reducing the threats from locally controllable stressors, enhancing genetic diversity, and restoring coral populations through coral farming (although to date on a limited scale) we may be able to provide coral reefs and associated ecosystems the respite they need to resist and adapt.
- ***An opportunity for science to step forward*** **–** Implementation of conservation practices

[1] Jackson et al. (2014). *Status and Trends of Caribbean Coral Reefs: 1970 – 2012*. Global Coral Reef Monitoring Network, IUCN, Gland, Switzerland.

inevitably involves making compromises. Difficult decisions regarding which ecosystems, stressors, and strategies to focus on are not trivial as these choices often have irreversible repercussions. However, coral reef conservation must continue regardless of the uncertainties involved. Scientific information is often inaccessible for decision makers, and potentially useful science can remain hidden and hence unused. Alternative venues facilitating the communication between scientists and decision makers must be created.

- ***Not just a coral reef problem*** – Some key stressors affecting coral reefs and associated ecosystems also represent environmental problems of utmost concern as these pose a risk to public health, coastline vulnerability, food security, and water resource availability, among others. Recognition of these linkages should serve to gather wider consensus on the multiple societal benefits gained by addressing these issues. Educational campaigns that explicitly highlight the economic benefits of functional coral reef systems could serve to further harness the support of both private and public sectors.

What can we do… better?

- ***Reinforce local efforts*** –Many local stressors related to land-based sources of pollution are potentially manageable at the watershed level as many proven mitigation practices are fiscally enforceable through already existing water and soil conservation regulations [*See Coral Bay-St. John inset*]. The same applies to curbing the effects of overfishing by effectively enforcing the proposed restrictions on fish extraction within Marin Protected Areas (MPAs).
- ***A focus on survival through adaptation*** – The genetic adaptability of modern reef-building corals (*Scleractinia*) has been essential in their survival since their emergence on our planet 240 million years ago. Helping corals adapt to current conditions by augmenting their genetic diversity could also play a significant role in their current struggle for survival, but so far little attention has been paid to this option as a potential management strategy.
- ***Managing through coral farming*** – Low-tech coral propagation, often empowered by community-based efforts, has become a cost-effective strategy to reestablish depleted coral species and essential fish habitat functions. However, these efforts have been limited to the scale of individual patches within specific reefs, and thus add limited community- and ecosystem-level benefits. Coral reef restoration through farming and planting can entail more than simply enhancing live coral cover or thicket formation, even if it results in reinstating depleted, slow-growing reef-building species. Coral farming must also foster landscape-level resistance and resilience through strategic planning that maximizes the chances of survival, enhances genetic and demographic diversity, and foments successful sexual reproduction.

Can you hear me now?

- ***Having a voice where it matters*** – Many of the decisions that affect coral reef ecosystems are effected in mostly inaccessible political and economic venues. For example, many coral reefs under United States' jurisdiction lie outside of the continental U.S., and as a result coral reef degradation remains distant and mostly irrelevant in the most pertinent political spheres. Failed attempts or the lack of opportunity to introduce a convincing argument supporting natural resource protection into those discussions is in part to blame for the lack of environmentally - conscious development models that consider coral reefs as an indispensable component of sustainable socio-economic growth [*See Río Magdalena-Islas del Rosario – Colombia inset*].
- ***Supporting community empowerment*** – The value of traditional ecological knowledge in recognizing and effectively responding to signs of coral reef degradation is generally underused. Empowered communities have been proven effective in leveraging coral reef stewardship efforts with government agencies, the private sector, and academia. Other benefits include technical training, enhanced entrepreneurship opportunities, improved quality of life, and truly participatory governance partnerships that could be replicated in other areas of the Caribbean [*See Culebra – Puerto Rico inset*].
- ***Lost in translation –*** Language barriers can further communication gaps as much of the technical information is mostly available in English. This is a particular concern for the Spanish, Portuguese and

French-speaking countries in Latin America and the Insular Caribbean.

- ***A Caribbean-wide information network*** – Given that regional coral reef degradation is linked to the proliferation of adverse local conditions, curbing of this declining trend requires the widespread replication of effective management strategies. An assemblage of concerned individuals from government agencies, non-government organizations, local communities, and academia such as the one emerging from The University of Texas' workshop is thought to properly represent society's concerns with regards to the degradation of coral reefs and associated ecosystems. The goal of this group is to internally and externally share experiences across geographic locales and backgrounds in order to better express and develop our arguments regarding coral reef conservation. This working group also seeks to communicate results in an adequate framework with simple language for decision makers and communities in general and to improve governance by identifying and building on success stories.

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CASE STUDIES

Local Stressors, Big Challenges- Akumal, Quintana Roo, México

Servicing an excess of 200,000 visitors per year, Akumal is undoubtedly one of Mexico's foremost Caribbean destinations. Land development supporting such a high volume of visitors has been mostly in the form of small luxury hotels and condos that have expanded the amount of built-up land by 200% over the past fifteen years. Concurrently, one of Akumal's most coveted attractions, its coral reef ecosystem, suffered a total cover loss of 77%. Research conducted by Universidad Nacional Autónoma de México at Sisal suggests that coral losses have been the result of an unprecedented high incidence of coral diseases following massive bleaching events in 1998 and 2005. The low resilience of Akumal's reefs has been associated to elevated nutrient concentration of its coastal waters, which is undoubtedly linked to contamination of groundwater aquifers by untreated sewage[2]. Even though parts of Akumal's coral reef ecosystem were declared Marine Protected Areas in 2015 and 2016 (a No-Take Marine Reserve and a Marine Wildlife refuge), the effectiveness of these actions as conservation efforts is limited in that they are meant to tackle stresses related to overfishing and tourist-access, and not to land-based sources of pollution. Even though regional efforts are being developed to address water quality issues, these are yet to alter waste water treatment practices to reduce coastal water contamination. Along with the limited environmental law enforcement in Mexico's Caribbean Coast, Akumal serves as an example of '*deterritorialization*'. Most dwellers are recent newcomers from other states throughout México and therefore lack the historical knowledge to become aware of the consequences of the deterioration of the region's marine environment. As a result, the community as a whole has lacked the cohesion necessary to effectively interact with stakeholders, NGOs, and the government. [For more information please visit http://redoctober.sisal.unam.mx]

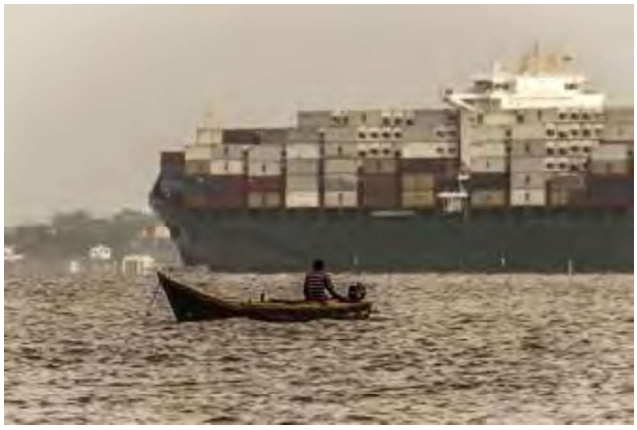
[2] Naranjo-García MJ & others. 2014. Role of sediments and nutrients in the condition of a coral reef under tourist pressure: Akumal, México. AGU Fall Meeting Abstract EP13F-06.

Executing Local Actions – Coral Bay, St. John – U.S. Virgin Islands

Even though fewer than 2,000 people live in the rural 3,000-acre watershed draining towards Coral Bay, unmanaged land development represents a serious threat to its marine ecosystems. The Coral Bay Community Council (CBCC) was formed in 2003 with the goal to address the most important issues affecting the Coral Bay community. From the beginning, the most commonly voiced concern was the need to address the sediment-laden stormwater plumes reaching the bay's coral-bearing waters, and this was in agreement with the scientific literature[3]. In 2007, CBCC began developing a Watershed Management Plan through a pair of NOAA and EPA-CARE grants. These grants enabled CBCC to hire a stormwater engineer to evaluate runoff problems associated to poorly regulated road construction. In 2009, CBCC partnered with another local non-governmental organization to secure a $1.5 million NOAA-ARRA grant to implement watershed restoration actions mostly intended to enhance the sediment retention capacity of the watershed through road drainage improvements and the construction of bioretention basins. The effectiveness of such watershed restoration measures have been evaluated by CBCC members and academic institutions such as the University of San Diego and The University of Texas at Austin. Findings reveal that water turbidity within the bay has noticeably improved and that restoration activities have reduced sediment yields by approximately 26%. Although much work still lies ahead, Coral Bay serves as an example of the possibility of executing local actions through partnerships amongst local communities, government agencies, and academic institutions. [For more information please visit:
http://www.coralbaycommunitycouncil.org]

Subcontinental-sized Stressors, Río Magdalena, Colombia

In addition to the same array of stressors affecting coral systems throughout the region, those located in the southwestern Caribbean may also be affected by large river systems originating as far away as the Northern Andes. With a drainage area of 257,000 km^2 and an average annual yield of 188 Million tons of sediment per year, Río Magdalena in Colombia is the main contributor of continental sediment fluxes to the Caribbean Sea. Since the 17th century, the 114-km long Canal del Dique has diverted about 5% of Río Magdalena's flow away from its natural deltaic environment, which includes the 4,280 km^2 lagoon complex of Ciénaga Grande de Santa Marta. Complications due to the artificial sediment accumulation patterns in the Canal del Dique and economic pressures desiring improved navigation through Río Magdalena led to the decision to open alternative outlets towards Bahía de Cartagena throughout the 20th century. This led to the obliteration of benthic communities of coral and seagrass beds in Bahía de Cartagena, now buried up to 12 m deep in recently deposited sediments. In addition, the relocation of the outlet of such a major river system has allowed large quantities of runoff, sediment, and other pollutants to gain access to Parque Nacional Islas del Rosario, a 145 km^2 area representing Colombia's major continental coral reef ecosystem[4]. Significant decreases in the abundance of coral cover in this ecosystem since the mid-1980s have been unequivocally linked to concurrent dredging activities along Canal del Dique. The Río Magdalena case serves as an example in which scientific information facilitated by an ensemble of academics supported by the private sector has introduced the



Bahía de Cartagena (Photo by ECORAL)

[3] Ramos-Scharrón & MacDonald. 2007. Measurement and prediction of natural and anthropogenic sediment sources, St. John, US Virgin Islands. *Catena* 71: 250-266.

[4] Restrepo & others. 2016. Coral reefs chronically exposed to river sediment plumes in the southwestern Caribbean: Rosario Islands, Colombia. *Science of the Total Environment* 553: 316-329.

Out-planted Staghorn coral in Culebra (Photo by SAM)

need for coral reef conservation into national-level economic development discussions. [For more information please visit http://www.ecoral.co/]

Community-Based Actions, Culebra Island – Puerto Rico

The island of Culebra has housed a number of community-based coral reef conservation projects. In collaboration with local agencies and the local community, two nonprofit organizations (Protectores de Cuencas Inc. and Ridge to Reefs Inc.) developed the Culebra Watershed Management Plan that identified numerous land-based sources of coastal water contamination including failing septic tanks and erosion hotspots, among others. Structural and non-structural erosion control methods, including hydroseeding and restoration of vegetated areas, have been implemented in a number of locations as a result of these efforts [http://protectoresdecuencas.weebly.com/]. Another type of project that has been implemented in Culebra is the *Community-Based Coral Aquaculture and Reef Rehabilitation Program*. Launched in 2003 in the island of Culebra through a collaborative effort led by Sociedad Ambiente Marino (SAM), the Culebra Island Fishers Association, Coralations, Inc., and the University of Puerto Rico at Río Piedras, the project was originally aimed at replenishing populations of Staghorn coral (*Acropora cervicornis*) depleted by military training activities. However, the project has expanded to include Elkhorn coral (*Acropora palmata*) and other locations even beyond Puerto Rico. Efforts have produced over 20,000 out-planted corals into depleted reefs which have resulted in fostering thicket development and documented increases in fish species richness, abundance and biomass. Moreover, the project triggered a significant switch in community-based participation through extensive hands-on training, education and participation. Efforts led to a major empowerment of SAM which aided in securing external funding, staff and volunteer training opportunities, and fomenting collaborations with academia and government institutions. As a result, SAM and UPR researchers have co-authored over 15 peer-reviewed articles about multiple topics beyond coral farming[5]. The SAM example serves as a model of how a single community-based coral farming project may evolve into an independently funded, multi-objective organization dedicated to coral reef restoration, education, and research [For more information please visit: http://sampr.org/es/].

[5] Hernández-Delgado & others. 2014. Community-based coral reef rehabilitation in a changing climate: Lessons learned from hurricanes, extreme rainfall, and changing land use impacts. *Open Journal of Ecology* 4(14): Article Id 50930.