

# CDHC Hawaii Workshop: VISION FOR ACTION

## Executive Summary

*“We are studying arguably the most complicated ecosystem on the face of the Earth, and it is under serious threat. ....We have an incredibly important message, if this ecosystem dies, if this ecosystem is otherwise perturbed to an extent that it cannot recover, not only does it spell potential disaster for this spaceship we call Earth, but there is no less than 80 emerging economies, nations that are entirely or nearly entirely dependent on coral reef ecosystems whether it be for the economy or for the subsistence.” (Dr. Gary Ostrander, University of Hawaii, opening remarks)*

Pacific coral reefs contain the highest diversity of marine organisms in the world with an estimated 1500 species of fish and over 500 species of coral. Yet these reefs are facing significant, multiple threats to reef community and habitat structures, resulting in local to wide-scale regional damage. Wilkinson (2004) characterized these pressures as including (1) global climate change, (2) diseases, plagues and invasive species, (3) direct human pressures, (4) poor governance and lack of political will, as well as (5) international action or inaction.

Pacific reefs are generally thought to be in good condition and most resource managers have no real concern about coral disease (regardless of whether the cause is an infectious agent or anthropogenic pollution), however, this ‘good’ condition status may only be a reflection of inadequate information in many areas. In fact, the 2005 NOAA report (Waddell et al., 2005) on the state of U.S. coral reefs contrasts this view, showing an increase in disease reports and documents a recent (between 2002-2004) perceived increase in the threat-level disease poses to Pacific coral reefs. The potential of an emerging disease crisis for Pacific reefs is signaled by a number of examples. One such example is illustrated in the 2004 World Bank Coral Disease Working Group (WBCDWG) surveys of just six Palauan reefs, which recorded 12 diseases and syndromes of the 40 reported to afflict corals and of these four were new pathologies, never before described (Waddell et al., 2005). Experience in identifying coral disease signs garnered from the Caribbean (where the destruction from disease has been catastrophic) has provided a basis for disease studies in the Pacific. Increases in regional reports of new disease signs among coral throughout the Pacific and findings of an increasing number and types of coral disease from targeted coral disease monitoring projects in the Pacific (i.e., WBCDWG and NOAA/USGS disease monitoring programs) are sounding important warning signals that warrant attention and action---now. In fact, some experts speculate that Pacific coral reefs are on a trajectory of degradation that lags behind the decimation experienced by Caribbean corals by only about 20 years, if nothing changes.

Recognizing the need and opportunity for a strategic plan of action to combat a possible health crisis for Pacific Reefs, the Coral Disease and Health Consortium convened a workshop with the express purpose of helping to organize and coordinate the U.S. scientific resources to focus specifically on coral health issues in the Pacific. The goal

was to promote the effective detection, identification and management of coral reef diseases in the Pacific. This report documents the proceedings of this workshop: *Coral Health and Disease in the Pacific: Vision for Action*.

The goals of the workshop were to:

- Synthesize the state of knowledge of Pacific coral diseases
- Discuss the concepts and principles of disease, their use in investigating causation and how this can be applied to corals
- Characterize the difficulties in identifying, defining and managing disease in coral
- Develop a *Strategic Research Plan* that
  - identifies knowledge gaps that impede understanding coral disease mechanisms (i.e., pathology), and limits elucidating causation, significance or control of coral disease (i.e., epidemiology)
  - recommends directed research and education to fill these knowledge gaps
  - standardizes methods for investigating coral disease outbreaks considering both biotic and abiotic etiologies
  - addresses issues relative to the management of coral reef resources
- Foster collaboration among CDHC partners and key stakeholders

The workshop incorporated diverse viewpoints from recognized experts representing a cross-section of the biomedical field, coral disease specialists and resource managers. Fourteen position papers were presented at the opening of the workshop that covered key topics: *What do we currently know about coral diseases in the Pacific?; What lessons have we learned from Caribbean disease outbreaks?; The Diagnostic Method; Disease Outbreak Investigation and Ecological Epidemiology, Systems Biology and Leveraging Post-genomic technologies* to provide context and concepts for the break-out group discussions. The participants were then assigned to one of four groups: (1) Coral Cellular Physiology & Pathology; (2) Coral Toxicology & Ecological Epidemiology; (3) Pathology of Infectious Disease; and (4) Preventing and Responding to Coral Disease in the Pacific Region: Management Perspectives. Each team was charged with identifying key impediments and making recommendations for strategic research priorities that comprise the *Strategic Plan of Action*.

The first objective was to provide a context for the discussions that were to follow. To do so, it was important to identify the features that set U. S. Pacific reefs apart from those in the Caribbean and other parts of the world. We learned that U. S. Pacific and Atlantic reef areas have similar political histories and were exploited through plantation agriculture though recently the economic bases of both regions are shifting from agricultural, primarily to tourism and development. The Pacific however commands the center of marine biodiversity with at least 580 recognized species of coral and over 200 genera. The hub of this diversity is located in a region of the western Pacific referred to as the 'coral triangle'. This diversity then diminishes from one island to the next across the Pacific to the east, with Hawaii having the lowest coral diversity. The most distinctive feature of Pacific regions is the traditional knowledge, laws and sustainable management practices that remain active in many islands. These customs and tribal governance are unique in that U. S. Pacific Islanders perceive their natural resources as valuable and an

integral part of their lives. In areas where these practices occur, their influences have successfully guided their management practices in contrast to 'western' ideas and practices. The most obvious difference between the Caribbean and Pacific however, is the sheer area and number of islands and atolls that exist in the Pacific, greatly exceeding those in the Atlantic. This in itself creates a degree of isolation for many of the Islanders. In one sense this situation is positive, as it means fewer anthropogenic stressors, however this vastness and high biological diversity creates logistical, biological and cultural challenges to research as the Pacific Islander population is spread over numerous islands often at great distances, resulting in diluted scientific resources and a lack of critical mass in many areas to recognizing and combating emerging degradation of their reefs.

An overview of the Global Diversity and Distribution of Coral Diseases (Bruckner, white paper this meeting) from the World Conservation Monitoring Centre's (WCMC) records (1972-2005) documents over 40 coral diseases from the western Atlantic, 28 from the IndoPacific and 5 from the Red Sea covering 63 countries. Over 150 species have been observed with disease (Sutherland, 2004) representing 39 genera. In the Caribbean this translates to 80% of all taxa (41 species of scleractinian, 8 gorgonians, 2 hydrazoans) being afflicted with disease. In the IndoPacific 97 species (approximately 17%) from 34 genera have been identified with disease and this is on the rise. These numbers reflect a 25% increase in genera and 45% increase in the number of species afflicted with disease since 1999, with 7 new genera in the IndoPacific observed with disease over the last 5 years. Recent surveys conducted in strategic locations across the IndoPacific (Australia, the Philippines, American Samoa, Northwest Hawaiian Islands (NWHI) and elsewhere) illustrate the widespread, global distribution of coral diseases with prevalence varying from a low of 0.14% in American Samoa to 0.5% in the NWHI and highs of 10% along the Great Barrier Reef (GBR) to 14% in the Philippines (Aeby – American Samoa white paper this meeting). In these areas over the last 5 years, regions previously unaffected are now reporting disease, while in other locations (i.e., GBR) there are increased reports in the percentage of reefs affected as well as new disease manifestations. Based on this and other information, it is reasonable to conclude that diseases in the IndoPacific are undergoing a rapid expansion in range and types of disease and *now* is the time to recognize the signs of a pending problem and take action.

Our understanding of coral diseases and thus the ability to combat the declining health of our reefs is limited by our lack of understanding of the basic biology and physiology of these organisms, and their responses and tolerances to changes in their environment. We are at the cross-roads---we can remain in the dark ages of medicine, as our understanding of coral disease has been described, or we can take advantage of the principles of wildlife veterinary medicine that have already been established and the technologies of a post-genomics era and apply them to coral health and accelerate the evolution of this field....not only to determine the cause, but how to manage disease in the reef environment.

## Recommendations:

- **Partner with the National Science Foundation to Engage a Broader Research Community to Develop a Knowledge-base of Coral Cellular Physiology through Directed Research Grants.** Our ability to understand coral disease pathology is hampered by a limited knowledge of coral molecular and cellular physiological functions. An understanding of these critical features of coral biology could be rapidly advanced by tapping into knowledge-base and skills that exist in the wider research community, but not yet applied to corals.
- **Adopt Model Coral Species for Research.** Identify representative reef building coral species from the Atlantic and Pacific that could be used in research studies to better characterize normal coral physiology and biological stress responses, and support culture facilities to propagate these corals (i.e., living stock collection) and make them available to researchers.
- **Adopt an *Ecological Epidemiology* Approach to Identify Risk Factors and Assess their Contribution in Coral Reef Degradation.** The principles and methodologies of epidemiology can be used to identify risk factors that impact coral health (e.g., toxins and pollutants that make corals more susceptible to diseases) and quantify the contribution of the various factors to adverse health effects. Implementation requires developing methods and tools to detect and track biological responses which can focus diagnostic efforts, and help direct and prioritize management actions toward risk reduction.
- **Develop a Systematic Approach to Investigate and Study Diseases in Corals.**
  - Identify and recommend standardized approaches to systematically investigate coral diseases, including a system of nomenclature and terminology to describe diseases, survey approaches and laboratory techniques to provide compatibility among data.
  - Develop a protocol for responding to coral disease outbreaks, train regional and local teams in disease investigative methodologies, including documenting case histories, assessing the area and extent of an outbreak using appropriate survey techniques, sampling techniques for specific laboratory analysis, and implementing systematic investigations in response to unusual coral disease outbreaks and mortality events.
  - Develop a bioinformatics system to track outbreaks, synthesize case data to identify drivers in outbreaks and provide data in a format easily accessible to researchers and resource managers.
- **Manage Coral Reefs to Reduce Stressors that may make Corals more Vulnerable to Disease.** The key to managing coral health and mitigating disease impacts is not through stereotypic routes of medication and treatments, but rather to identify causes of coral diseases, including relationships with manageable anthropogenic and environmental stressors. The most controllable environmental factors are those associated with land-based sources of stressors; understanding

disease dynamics can identify control points in a disease cycle that can also be used in management strategies.

- **Create and Support Advanced Educational Opportunities.** There is a critical need to build scientific capacity in the field of coral pathology and disease management skills in reef resource management. These programs should include development of advanced degree (e.g., Master's degree) programs in coral pathology as well as continuing education in specialty topics (e.g., disease identification for resource managers; disease investigation methods; environmental forensics) for professionals (i.e., resource managers).
  
- **Develop Guidance for the Proper Handling and Containment of Corals in Infectious Disease Experiments.** An important outcome of this workshop was the recommendation by the participants to accept the following guidelines for the care and handling of corals in experimental settings:
  - Field Challenges should be carefully regulated and until the levels of risk can be assigned by careful laboratory studies, the CDHC recommends that no field challenges with infectious pathogens be conducted.
  - CDHC does not currently recommend the export of laboratory reared coral back into the field, until suitable tests are available for assuring these coral do not pose a threat to the wild populations.
  - The CDHC recognizes the need for biosecurity and bio-containment guidelines for conducting laboratory challenge experiments with candidate infectious agents and toxicants and recommends establishing a steering committee to develop these guidelines that are consistent with existing guidelines for handling and containment of infectious agents in wildlife as well as protocols for hazardous materials handling.
  
- **Foster the Development of a Cohesive Coral Disease Research Community.** The CDHC should provide a focus for cross-cutting priority research needs and a framework for interaction and collaboration among the coral disease research community.