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US-Cuba Scientific Collaboration

Emerging Issues and Opportunities in Marine and Related Environmental Sciences

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INTRODUCTION

Despite diplomatic nonrecognition, vast political differences, a long-standing trade embargo, and strict limitations on travel, US-Cuban scientific collaboration is on the rise. In December 2011, independent US scientists traveled to Havana, Cuba, for a series of scientific discussions with members of the Cuban scientific community. The American Association for the Advancement of Science (AAAS) and the Cuban Academy of Sciences facilitated the trip. One topic for discussion concerned emerging issues and opportunities in marine and related environmental sciences. Shared resources (e.g., Gulf of Mexico fisheries) and high connectivity between US and Cuban ecosystems via regional oceanic and atmospheric circulations underscore the importance of increased US-Cuban cooperation in this field.

Discussions covered potential areas for collaboration, impediments that make US-Cuban scientific collaboration difficult, and possible actions to improve opportunities for shared US-Cuban science. For these discussions, "marine and related environmental sciences" included basic and applied research in the biological, socioeconomic, and interdisciplinary sciences applied to watershed, coastal, and marine systems. The Havana discussions stressed the importance of "bi-directional" collaboration, with Cuban and US scientists collaborating on scientific activities in both Cuba and the United States. Here, we summarize the outcomes of the December 2011 discussions.

MARINE SCIENCE IN CUBA

Cuba is the largest island nation in the Caribbean in terms of population (> 11 million), land area, and coastline, with a large coastal platform and island archipelagos. Extensive marine habitats include mangrove forests, seagrass meadows, and coral reefs, large areas of which are protected conservation zones. Mangroves border 3,211 km of coastline, and seagrass meadows comprise 26,563 km^2 of coastal habitat. These attributes, along with Cuba's geographic position between the Gulf of Mexico and the Caribbean Sea, result in the largest marine biodiversity in the Caribbean, with more than 7,000 identified species. The Cuban coast is buffered from substantial anthropogenic pressures by adequate surrounding oceanic circulation and the absence of large rivers that would enhance terrestrial runoff. In addition, Cuba has one of the lowest ecological footprints (1.5 hectares per capita) in the Caribbean (WWF, 2006). These attributes make Cuba an important location for marine collaborative research.

Primary marine institutions in Cuba include the following, located in Havana: the Center for Marine Research at the University of Havana; the Center for Fisheries Research in the Ministry of Food Industry; the Institute of Oceanology in the Ministry of Science, Technology and Environment; the Center for Engineering and Environmental Management of Bays in the Ministry of Transportation; and the National Aquarium. The Center for Coastal Ecosystems Research is located in Ciego de Avila. These institutions currently pursue fisheries research and resource management, marine pollution prevention and mitigation, coastal zone management, environmental management of areas targeted for socio-economic development, protection of marine biological resources, and global change research.

EXISTING COLLABORATIONS

Several US institutions have had long and fruitful collaborations with the Center for Marine Research at the University Havana (CIM-UH). These collaborations have focused on four major research areas: sea turtle biology and conservation, coral reef ecology, manatee biology and conservation, and shark biology and conservation.

Since 1999, the sea turtle conservation collaboration has involved CIM-UH, The Ocean Conservancy, and The Ocean Foundation in a research project on the Guanahacabibes peninsula on the western end of Cuba. This project has been in place for 14 years, producing outstanding results on sea turtle biology, demography, genetics, and environmental education with the participation of hundreds of volunteers (Azanza-Ricardo et al., 2003, 2006; Ruiz-Urquiola et al., 2008, 2010). Similarly, the Proyecto Costa Noroccidental (PCN), or Northwestern Coast Project, has brought together diverse entities, including The Ocean Conservancy, Harte Research Institute, The Ocean Foundation, and Mote Marine Laboratory, all working with CIM-UH since 2003. This project has significantly increased knowledge about Cuba's northwest coastal region by undertaking a biodiversity inventory, characterizing ecosystems, and describing the major threats affecting the area's coral reefs ecosystems (e.g., Armenteros et al., 2007, 2009; Hernández et al., 2008; González-Díaz et al., 2008, 2010; Gonzalez-Sansón et al., 2009a,b; Elizalde-Rendón et al., 2010).

The study of manatees and sharks has involved collaborations with other important institutions, including the Sea to Shore Alliance and Environmental Defense Fund. Bilateral activities in shark research and conservation have been led from the US side by the Mote Marine Laboratory and have included field surveys of shark fauna in Cuba, tagging studies to investigate connectivity between Cuba and the United States, characterization of Cuban shark fisheries, and educational programs in shark research in both countries. Results (e.g., Álvarez-Alemán et al., 2010, 2011; Ortíz et al., 2010; Hueter et al., 2011) from both projects are highly promising and have encouraged new ideas for marine research. These examples demonstrate that collaboration between US and Cuban scientific institutions is possible despite the challenges.

EMERGING ISSUES AND OPPORTUNITIES

Critical issues and opportunities for future US-Cuba collaboration in marine and related environmental sciences include: (1) ecosystem approaches to collaborative science, (2) studies of environmental change, (3) conserving biodiversity at large scales, (4) food security through sustainable fisheries and aquaculture, and (5) capacity building for collaborative science.

Ecosystem Studies

Ecosystem studies hold considerable potential for US-Cuba marine and environmental science. Research can be organized and conducted at the ecosystem scale; key ecosystems are mangrove, seagrass, coral reef, and pelagic systems, among others. Emerging ecosystem research can build upon existing species-level collaborations within and across ecosystems, including current collaborative research related to sharks, sea turtles, and marine mammals. Collaborative research is also needed to identify critical ecosystem services and estimate values (both economic and nonmonetized) to particular key economic sectors such as fisheries, aquaculture, and tourism. In addition to advancing scientific understanding of shared and similar US-Cuban marine ecosystems, the results can be usefully applied to Marine Protected Area (MPA) management important to both countries.

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Studies of Environmental Change

Studies of environmental change hold significant opportunity for US-Cuban collaborative science. Understanding the complexity of climate change/variability on marine and coastal ecosystems via sea level rise, ocean acidification, ocean warming, and altered storm patterns can benefit from comparative studies and research using shared monitoring and modeling expertise. Detection of invasive species such as red lionfish (*Pterois volitans*) and research on their impact on marine ecosystems are of special importance. Collaborative development of early warning monitoring systems would allow both countries to act quickly and decisively to manage harmful invasive species and mitigate ecological and economic consequences of invasions. In addition, shared data and methodological techniques for identifying eutrophication and water-quality trends (such as hypersalinity and contaminant levels) can be of significant benefit for US and Cuban resource managers and policy.

Conserving Biodiversity at Large Spatial Scales

The US and Cuba share biodiversity at large spatial scales; an example is the movement of large pelagic fishes between US and Cuban waters through the Straits of Florida. Collaborative US-Cuba biodiversity research (particularly for marine, coastal, and watershed systems) should identify shared biodiversity at multiple levels from genetic through higher guilds, and use multiple diversity measures including but not limited to species richness. New technologies and techniques allow for increasingly fined-grained spatial analysis, and the results of collaborative US-Cuba research can directly inform MPA management in both countries.

Food Security: Sustainable Fisheries and Aquaculture

The link among food security, sustainable fisheries, and aquaculture is a shared opportunity for collaborative US-Cuba marine science. Such research has potential to inform and improve marine food production systems and resource management in both countries. Joint assessments of shared fish stocks can improve sustainable fisheries management (e.g., Hueter et al., 2011). The development and promotion of integrated coastal zone management can directly benefit from the results of US-Cuba research, as can ecosystem approaches to conserving shared and similar fisheries. Research to develop environmentally friendly approaches to aquaculture (particularly for shared cultured species), as well as new techniques and technologies, can benefit both countries. Social science research can (even in the context of dramatically different political systems) identify mechanisms and best practices for environmental stewardship, including conflict resolution, inventory and monitoring systems, coastal zone management, and more.

Capacity Building

There is significant value in and need for capacity building to increase US-Cuba scientific collaboration. Existing collaborations (such as the Trinational Initiative for Marine Science and Conservation in the Gulf of Mexico and Western Caribbean that involves the United States, Cuba, and Mexico) can be expanded and new collaborations established. Such collaborations often lead to joint publications in the scientific literature that further develop trust and credibility. Information exchange (both data and metadata) and sharing of high-resolution sensing imagery and skills within security constraints of both countries have resulted in successful international collaboration. For example, Perez et al. (1999) described interactions between the Yucatán Current and the continental shelves off of Mexico and Cuba that create strong frontal zones separating clear unproductive water bodies from waters that are biologically rich. Other capacity-building opportunities include: (1) identifying authorities and institutions that can facilitate collaboration; (2) creating advanced graduate training initiatives that involve both US and Cuban students (e.g., in coastal zone management); (3) improving international collection agreements that cover voucher specimens, loan arrangements, benefits sharing, and so forth; and (4) increasing public outreach about marine science.

An additional and important capacity is related to the need for scientific exchange during crises, such as the 2010 Deepwater Horizon oil spill. Creating workable arrangements for real-time collaboration before joint crises arise (from oil spills to hurricanes) can greatly improve the functioning of critical research and delivery of science-based assessments to decision makers.

CONSTRAINTS ON COLLABORATION

The experiences of US and Cuban scientists engaged in previous and ongoing collaborations identify a number of constraints, and an enhanced US-Cuban

scientific exchange is dependent on the capacity to overcome, reduce, or mitigate these impediments. Constraints include: (1) travel and permit restrictions; (2) mail and shipping limitations; (3) difficult Internet access; (4) limited infrastructure (such as research vessels and instrumentation); (5) restrictions on US training of Cuban students; (6) restrictions on technology transfer; (7) limits on the use of global positioning systems (GPS) to locate study sites; and (8) limited available and allowable funding.

POTENTIAL ACTIONS

In the Havana discussions, a range of possible and productive actions were raised for consideration. Some were modest in scale, such as: (1) encouraging US and Cuban scientists to contribute to internationally held databases (such as the Barcode of Life Project); (2) convening a scientific technical meeting on one or more of the above topics, to be held at a jointly accessible location; and (3) promoting increased attendance of US scientists at MarCuba, Cuba's premier international marine science meeting held every three years.

Other potential actions are both larger scale and longer term, including: (1) establishing formal research agreements at the institution-to-institution level; (2) developing a strategic plan for marine and related environmental science that engages US, Cuban, and other nations' scientists in collaborative planning; (3) developing a coherent and coordinated fundraising campaign with foundation support that increases resources available for US-Cuban scientific exchange; and (4) creating a "clearinghouse" of collaborative activities so that interested scientists can efficiently find information, identify potential research partners, and share scientific results. One fruitful strategy for collaboration would be a focus on place-based research, and several key locales have outstanding potential. These sites include (in Cuba) the southern portion of the Zapata Swamp and the contiguous marine environment, including the Bahia de Cochinos and Golfo de Cazones, and the Jardines de la Reina Archipelago; and (in the United States) Florida Bay and the Florida Keys, among others.

Participants in the Havana discussions considered their conversations productive. We encourage a larger group of scientists to join the dialogue on US-Cuban scientific collaboration. Marine and related environmental sciences, the scientific community, and both nations will benefit.

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During the 2012 Ocean Sciences Meeting, Emmanuel Boss demonstrated several hands-on activities with enthusiastic participation from meeting attendees. *Photos courtesy of Fred Dobbs*