The Coral Reef Sentinels Program: A Mars Shot for Blue Planetary Health

David I. Klinsez1, Alex Delgado2, Paul Bunje3, Shah Sehba4, Ved Chirayath5, Oscar Pizarro6, Matthieu Leray7, Sean Connolly8, Pim Borgaard9, Tali Trebitz10, Oren Levy1, David Kriegman1, Andreas Andersson1, Melanie McFadden1, and J. Emmett Duffy11

1Smithsonian Tropical Research Institute, Conservation X Labs, Conservers, NASA Ames Research Center, University of Sydney, California Academy of Sciences, University of Halia, Bar Ilan University, University of California, San Diego, 2Smithsonian National Museum of Natural History, 3Smithsonian Environmental Research Center

Corresponding author email: klinsez@si.edu

ABSTRACT

Up to 90% of global coral reefs are predicted to be severely degraded by 2050 under “business-as-usual” scenarios. To meet the scale and scope of this challenge, we propose designing and demonstrating a multi-modal system that can incorporate data from remote sensing (satellites, aircraft, and aerial drones), acoustics, genetics, sensor arrays, and low-cost imaging systems. The latter will be collected by low-cost smart sensing and autonomous underwater vehicles (AUVs) guided by adaptive sampling modeling software and rapidly analyzed using automated machine learning systems. Development and deployment will be linked to extensive and diversity-enhancing training programs. The Coral Sentinel System will be globally deployed to enable rapid-response adaptive management and to build public engagement in conservation interventions to save coral reefs.

Phase 1 (Year 1) will involve testing assumptions, coalition building, fundraising, and initial system development. Phase 2 (Years 2-4) will focus on engineering and development with a pilot deployment in the Caribbean. Phase 3 (Years 5-6) will involve system expansion and iteration along the Tropical Eastern Pacific corridor. Phase 4 (Years 7-10) will involve global deployment to over 50 reef sites. This will lead during the following decade (Phase 5) to provisioning of low-cost Sentinel systems to coastal communities globally.

Vision and Potential Transformative Impact

Coral reefs are the most biodiverse ecosystem in the ocean, providing habitat for millions of species, supporting over half a billion people, and providing billions of dollars in income annually. However, coral reefs are being lost at an unprecedented rate, which is accelerating due to mass bleaching and ocean acidification, exacerbated by local human impacts.

Our ambitious, achievable, and transformative Coral Reef Sentinels program will deliver actionable data and knowledge about the health and state of coral reefs in near real-time and enable conservation interventions to protect these reefs from harm while ensuring local ecological, economic, and cultural health. We will design and demonstrate an integrated, scalable monitoring, modeling, and decision-support system for reef science and conservation involving remote sensing (satellites, aircraft, aerial drones), sensor arrays, acoustics, eDNA, and imaging systems on fleets of low-cost AUVs powered by artificial intelligence. It will be deployed on reefs around the world to measure coral reefs’ responses to environmental changes and efficacy of conservation interventions guided by information processed in near-real time. This will facilitate rapid-response adaptive management, enhance public awareness about ongoing changes to coral reefs, and build local capacity to monitor and respond to changes to local reef systems.

Realizable, With Connections to Existing U.S. Scientific Infrastructure, Technology Development, and Public–Private Partnerships

The Coral Sentinel program brings together scientists, engineers, computer scientists, and conservationists from the Smithsonian Institution, NASA Ames, the Scripps Institution of Oceanography, the University of California, San Diego, the California Academy of Science, and Arizona State University, as well as public-private partnerships with Conservation X Labs and Conserver. We also have partnerships with social scientists, environmental lawyers, and conservationists at the Watt Institute and the Smithsonian’s Healthy Reef Initiative.

Scientific/Technological Sectors Engaged Outside of Traditional Ocean Sciences

We are engaging computer scientists with expertise in AI and machine learning (UCSD; NASA Ames, University of Sydney); engineers from non-profits (Conservation X Labs and Conserver); and from NASA Ames, the University of Sydney, and the University of Halia; and social scientists, environmental law experts, and conservationists from the Watt Institute and the Smithsonian’s Healthy Reef Initiative. Through citizen science projects (NASA’s NeMoNet, Squidde) and TV and film productions about the project (Nalu Creative, Luc Hardy, James Nktine and Fabiano D’Anotto), we will educate and motivate the public globally to join in Sentinel efforts to save coral reefs.

Opportunities for International Participation and Collaboration

Currenty we have international partners at the University of Sydney, the University of Halia, Bar Ilan University, and at the Technion. Through our collaborations with Smithsonian’s Healthy Reef Initiative and the Watt Institute we will engage and collaborate with coastal communities at over 50 reef sites globally. Our ultimate goal is to provide low-cost automated technologies that coastal communities around the world can use to protect their local coral reefs. Our global partnership of leading conservation organizations, research institutions, technology providers, and civil society groups will develop, implement, and ensure permanent long-term effectiveness of this program.

Develops Global Capacity and Encourages the Development of the Next Generation of Ocean Scientists, Engineers, and Technologists

The Coral Sentinel program will build on partnerships with coastal communities globally to provide technology and training to empower local management and protection of coral reefs. At all partnering institutions we will offer fellowships to next-generation ocean scientists, engineers and computer scientists, with a focus on growing diversity, to support and enhance global efforts to save coral reefs. We also plan to provide training and opportunities for collaboration for local ocean scientists in every country where we work, to empower and train the next generation of scientists in countries around the world.

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