13th International Coral Reef Symposium, Honolulu, 2016, Workshop Session Summary

The science and management of water quality on coral reefs

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The National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program has identified three high-priority threats facing coral reefs: impacts from fishing, impacts from land-based sources of pollution, and impacts from climate change. As a co-chair of the U.S. Coral Reef Task Force, NOAA collaborates with other task force agencies on the science and management of coral reefs. NOAA staff members working on issues related to land-based sources of pollution around the country also contribute to the Coral Reef Task Force Watershed Working Group. Through this collaboration, NOAA staff members have found that many partners share similar challenges with the science and management of land-based sources of pollution.

Recognition of these common challenges indicated a need to shift the definitions or approaches of how land-based sources of pollution are studied and managed. The Coral Reef Conservation Program offered a workshop at the International Coral Reef Symposium to gain perspective and insight from resource managers on some of the management challenges the program and its partners face, and to share those challenges with researches to enable them to develop the science to meet those needs. The workshop attracted participants from a range of universities, governments, and nongovernment organizations from across the globe. Highlighted below are some of the discussion topics and next steps that came out of the workshop.

Challenges to coral reef conservation

Workshop organizers identified in advance several common challenges that agencies find when working on reducing land-based sources of pollution. These challenges include limitations in

funding and technical capacity, inefficient indicators of water quality, incomplete science behind mitigation actions, missing baselines, model accuracy, and the need for better tools and data (weather data, sediment budgets, etc.).

Participants were divided into groups to discuss the following questions.

- Rather than the standard suite of nutrients, sediment, and other water quality parameters, is there a condensed set of parameters that are best for monitoring land-based sources of pollution for coral reefs? What are the key constituents that are impacting coral reefs, and what are the trigger levels for managers to be aware of? Are there ways to adequately estimate when resources are approaching those trigger levels of concern?
- Modeling is often proposed as a means to obtain estimated trigger levels; however, models have not been at a scale to sufficiently calibrate or ground-truth, or are not transferable between watersheds and are thus not useful for direct management. Are there new or better models that can achieve this?
- Are there more effective ways to find out information about impacts to coral other than from water quality monitoring (e.g., satellite imagery monitoring, tissue sample collection from marine species, etc.)?

Indicators and thresholds for corals

While the biological condition gradient is one approach, it was acknowledged that it can be difficult to separate out individual drivers thus developing indicators that demonstrate a shift in coral reef function was identified as a priority need. A tiered approach was discussed, which would include, first, identification of existing water quality problems, second, a determination of whether water quality was affecting coral reefs at the site, and third, if a problem was identified, the next steps that would include analysis of the source and the extent of the effect.

The need to define thresholds of various parameters, whether water quality or biological, for management action was identified. Examples discussed during the session included the water quality guidelines developed for the Great Barrier Reef; U.S. Environmental Protection Agency biological condition index and narrative water-quality standards developed for the U.S. Virgin Islands and being developed for Puerto Rico; and Hawaii's ecological gradient model. These various efforts took a number of approaches, such as identifying thresholds for chlorophyll a and turbidity; linking water quality parameters to key biological responses such as crown of thorns

larval response, macroalgae cover, and coral biodiversity; incorporating narrative water quality standards to account for the functional state of the ecosystem rather than only the physical state of the ecosystem; and utilizing multivariate statistics to identify which factors were most important in describing coral reef health. Limitations to these approaches were also discussed, including the need to understand the ecosystem and establish thresholds before arriving at the ecosystem tipping point.

Utility of models

Another topic of discussion in the workshop was the use of models for better understanding the impacts of management actions. The group agreed that models are only as effective as the data used to run them. Data are a primary limitation in many areas that Coral Reef Conservation Program partners operate. The discussion also highlighted that it can be difficult to capture signals from small management actions. The group concluded that in order to make models more effective for managing land-based sources of pollution in data-limited areas where our partners work, it is necessary that we explore the transferability of models that have been calibrated in one area to another area.

Available tools for coral reef managers

Possible alternate tools for data collection and indicators were brainstormed, some of which were already being developed or used and could be expanded for broader management applicability. The use of hyperspectral sensors for optical information was a discussed option, as were the indicators that could be informative for this purpose. Use of satellite data could be enhanced, and expansion to mobile platforms such as drones may have potential. The application of ocean color products could be expanded to include other constituents or parameters for water quality. One discussed option for exploration was dissolved organic carbon to determine whether it had an optical signature. The use of new technologies to analyze nutrient impacts, such as algae or seagrass tissue analysis for nutrient loads, was also highlighted. And there were reminders during the discussion that resource managers need to utilize qualitative data through local community knowledge and experience.

Related considerations

Other topics that deserve further consideration when looking at these challenges were mentioned briefly. Acknowledging that the threat to public health is a strong trigger for management action could help with framing how research and issues are approached. And emerging contaminants (such as microplastics) need to be kept on the radar, since these could potentially have large ecosystem impacts, could be used as effective proxies for other variables, or could disrupt or mask the impacts of other constituents being researched for management action.

Next steps

The NOAA Coral Reef Conservation Program is currently conducting evaluations of various aspects of its program, and in the coming year will be developing five-year goals and objectives for all three of its priority threat areas, including land-based sources of pollution. The discussions from this workshop will help to inform the program as it defines more targeted research questions to strengthen its management portfolio. The Coral Reef Conservation Program aims to continue engaging researchers in the field to fill needed information gaps. And continued coordination with U.S. Coral Reef Task Force partners will enable the introduction of new techniques and ensure sharing with all relevant partners.