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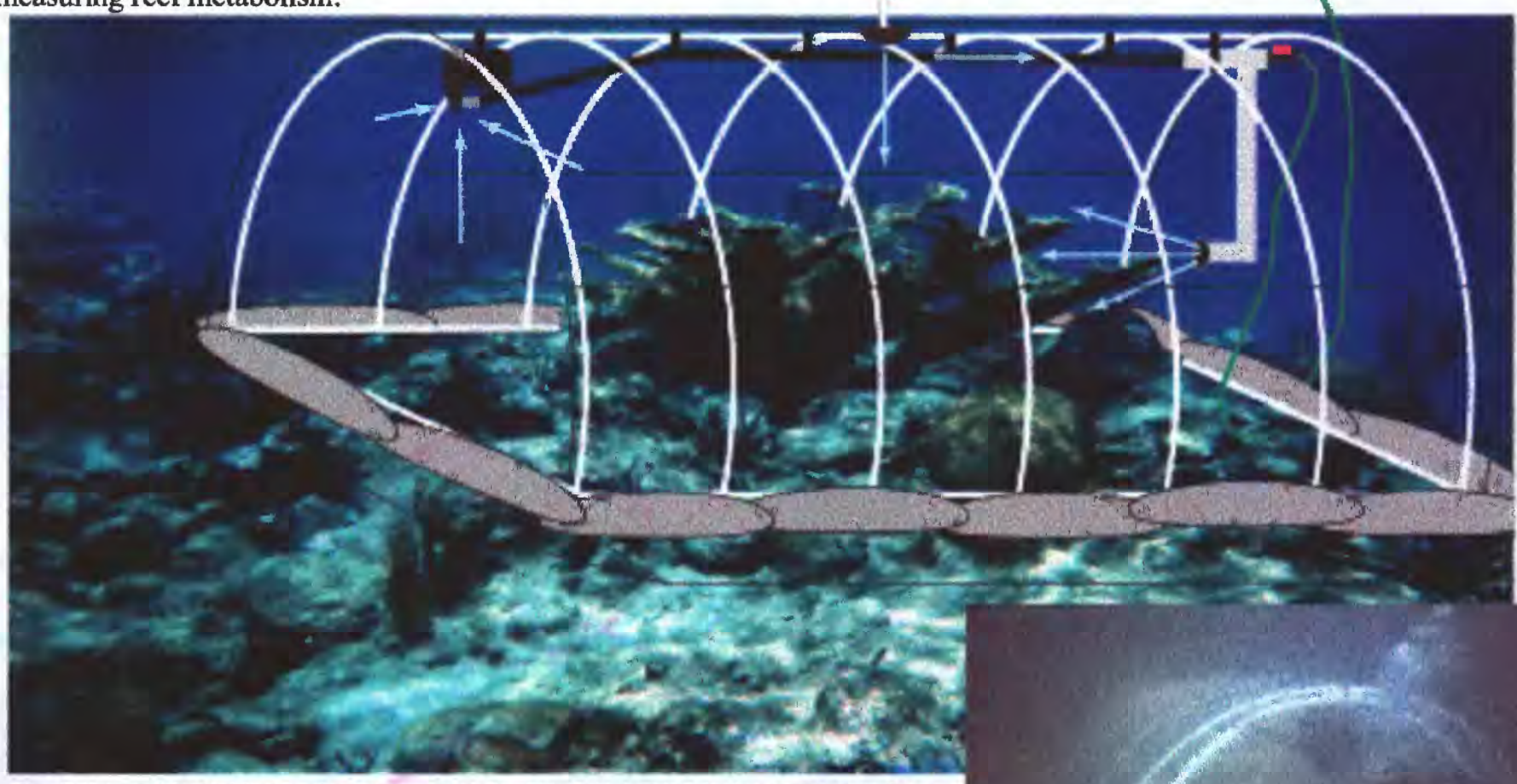
SHARQ Infested Waters

Over the last two decades, a variety of natural and human-induced stresses have caused a decline in coral reef health around the globe. The success of coral reefs results directly from their ability to develop a structural framework of carbonate skeletal material and sediments through one of the more fundamental coral reef metabolic processes known as calcification. It is this 3-dimensional framework which shapes coastlines into a variety of reef habitats that support a diverse community of marine life.

Unhealthy reefs typically show a decrease in living coral and an increase in fleshy algae. Rates of calcification decrease, and more of the available carbon is used for growing fleshy tissues of the algae through photosynthesis than is used for producing calcium carbonate skeletons for the coral reef. Despite the significant role of reef metabolism, including calcification, photosynthesis, and respiration, in maintaining healthy coral reef ecosystems, there have been no known efforts to monitor metabolic function as an indication of reef health due, in part, to the difficulties in measuring reef metabolism.

Scientists of the U. S. Geological Survey's (USGS) Coastal and Marine Geology Program have developed a method for trapping water over a coral reef community by placing a clear tent, 16' long x 8' wide x 4' high, over corals on the seafloor. This device, known as the **Submersible Habitat for Analyzing Reef Quality, or SHARQ**, allows investigators to measure changes in the chemistry of the trapped water that result from metabolism of the portion of coral reef community located inside of the tent. It also allows them to change environmental conditions inside the tent to observe the response of the reef communities.

Currently, USGS researchers are collaborating with scientists from USGS Biological Resources Division, NOAA, and the University of Miami to determine relations between coral reef metabolism and environmental conditions, and to develop methods for monitoring reef metabolism as an indication of reef health.



The Submersible Habitat for Analyzing Reef Quality (S.H.A.R.Q.) is designed to isolate a mass of water overlying the ocean bottom enabling 24 hour monitoring of temporal geochemical changes associated with benthic activity and in situ alteration of chemical and physical parameters for experimentation on the effects of environmental quality on coral reefs. Arrows indicate water flow.

Historically, reef metabolism has been measured by observing changes in the chemistry of seawater surrounding coral reefs that result from metabolic functions. This has been a difficult task because the complex shape of reefs causes water to move over reefs in an irregular manner, and scientists must be able to track a water mass as it moves across a reef so they can measure its water chemistry. Measurements of community-level reef metabolism have, therefore, been very limited.

Constructed from a PVC frame which disassembles into 8 foot sections for transport, the SHARQ is easily assembled underwater by SCUBA divers. The SHARQ is also being used to monitor metabolism and geochemistry in benthic communities in Florida Bay and whitings in the Bahamas.

In addition to investigations of coral reef metabolism, the SHARQ has been used to study bottom-dwelling, or benthic, communities in Florida Bay and marine "whitings" in the Bahamas.

Florida Bay is a shallow body of water that lies between the Florida Keys and the southernmost coast of Florida. During the last century humans have altered the landscape of South Florida and changed the Florida Bay environment. As a result, land and water use managers have undertaken a program to restore Florida Bay to a more natural state.

USGS researchers (in collaboration with Everglades National Park, the South Florida Water Management District, the Fish and Wildlife Conservation Commission, and the University of Miami) are using the SHARQ to determine baseline metabolism rates of many benthic communities in addition to coral reefs, such as seagrass beds and algal mats, and to measure carbonate sediment production in Florida Bay. As new water management practices are put in place and restoration efforts progress, continued monitoring of these benthic communities will reveal their response to environmental changes in the Bay. Managers will then be able to assess whether the changes in the marine communities are what were intended, and to evaluate the success of efforts to restore the Bay to a more natural state.

The phenomenon known as "whitings" (patches of water approximately 1 to 2 kilometers in length and width that appear milky-white due to suspended calcium carbonate sediment) occurs in the Bahamas and many shallow, tropical seas around the world. Whitings are dynamic, constantly changing shape as they move with tidal and wind-driven currents, making it difficult to investigate them during the day and impossible at night. Determining the significance of whiting formation in carbon cycling and sediment budgets has been problematic due to conversies on the origin of whitings. Much of this controversy has resulted from difficulties in measuring geochemical changes in whitings that indicate whether the carbonate sediment is made in the water column or resuspended from the bottom.

Recently, USGS and University of South Florida investigators have shown that whitings are associated with blooms of microbes such as blue-green algae and unicellular green algae. USGS scientists have been funded by the Department of Energy to examine the role of microbes in whitings formation and the effects of this phenomenon on carbon dioxide cycling. Using the SHARQ, researchers trapped whitings water on the Bahamas Bank and, for the first time ever, measured geochemical changes in whitings over 24 hour time periods. Results from these studies indicate that calcium carbonate sediment in whitings is precipitated from seawater.

It is well known that inorganic calcium carbonate sediment production generates carbon dioxide. USGS scientists also measured air-sea carbon dioxide fluxes in whitings, for the first time, using a floating bell that traps a small volume of air directly over the water's surface. These measurements indicate that carbonate sediment production in whitings does not generate carbon dioxide and suggests that sediment production in whitings is linked to microbial metabolism. These findings are significant because they suggest that whitings formation may act as a sink for carbon dioxide.

The SHARQ has proven to be a very useful tool for examining interactions between bottom-dwelling communities and the water column. Many investigations using the SHARQ have focused on using it as a monitoring tool to measure geochemical changes associated with coral reefs, seagrass communities, benthic algal mats, and whitings. However, the SHARQ can also be used to examine interactions between the water column and bottom substrate in a variety of different environments such as lakes, rivers, bays, and estuaries. The SHARQ also provides a mechanism for changing environmental parameters (such as salinity, nutrients, carbon dioxide, and turbidity) in the natural environment for experimental investigations on how these changes affect benthic communities. Future investigations using the SHARQ as an experimental tool will help researchers predict the effects of environmental perturbations on coastal ecosystems.

Floating bell used to measure air:sea CO_2 gas fluxes in whitings. The bell attaches to a LiCor CO_2 gas analyzer.

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