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Reef of Hope:

Visiting Pulley Ridge's Deep Coral

By Tim Taylor

It has been more than a year since I descended 230 feet below the surface of the ocean to be amongst the first to physically touch bottom and photograph the United States' deepest coral reef—Pulley Ridge, the healthiest reef I have seen in my lifetime. This past summer, I hosted my sixth major coral research project in the past year and a half, with a group of National Park Service (NPS) coral biologists. They revisited a shallow reef that has been under their study since 1997 and are conducting a monitoring program designed to track the health of this coral reef system. In stark contrast to Pulley Ridge, the NPS project is the documentation of a reef in decline, as are most of our shallow-water reefs these days. Yet Pulley Ridge, the deepest known light-dependent coral formation in the United States, is seemingly without disease issues. It draws its energy from sunlight and is made up of corals common to shallow reefs all over the Caribbean. Could this be hope's reef? Is it a key to understanding the health and sustainability of the corals? Can it help us save the shallow-water reefs?

Left: Open-circuit technical diver Eric Osking makes one of many decompression stops on his return from Pulley Ridge.
Above: The Mote Marine Lab dive team runs video transects and samples life forms at 230 feet in what the divers referred to as the cabbage patch.

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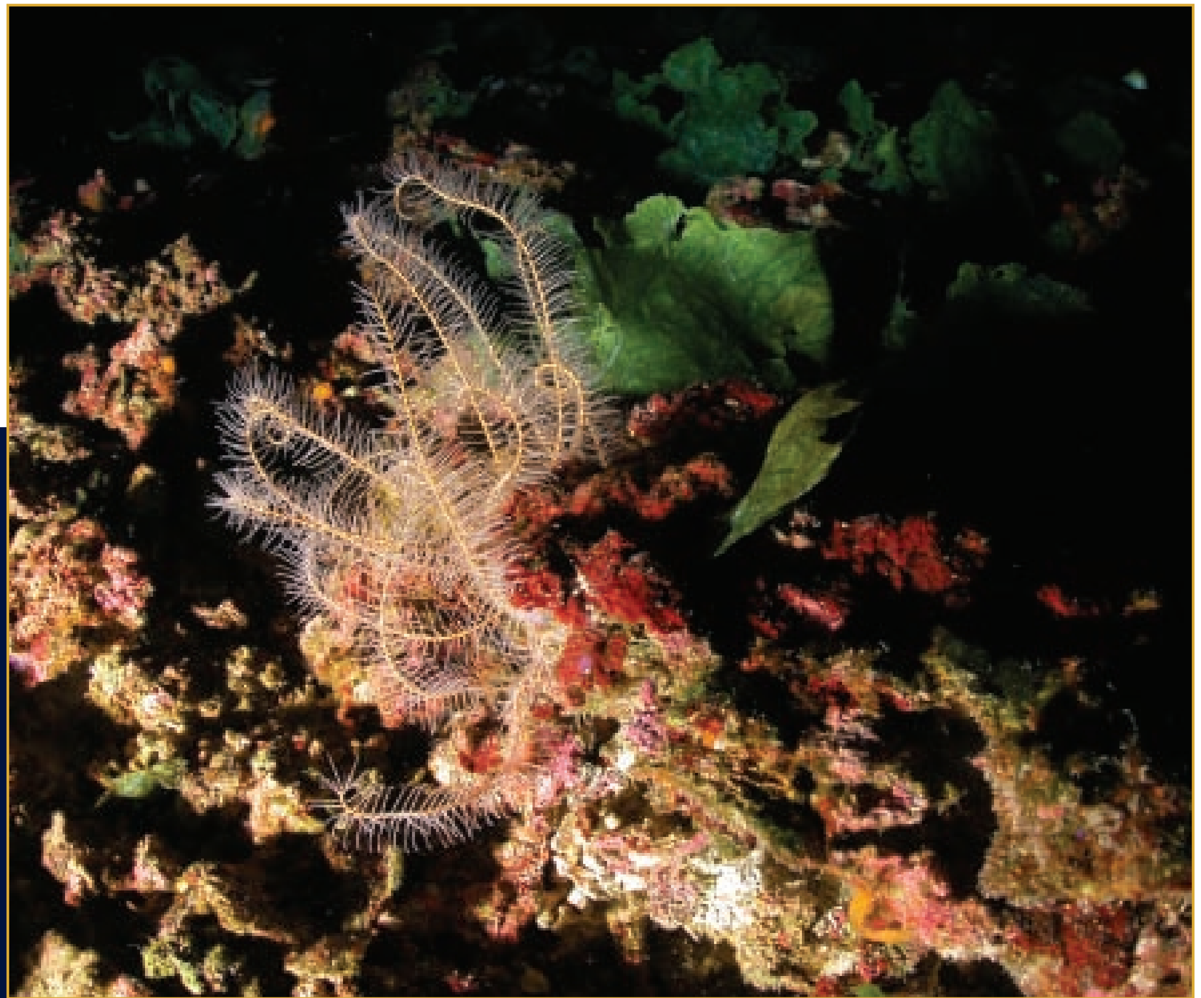
The amazing thing about Pulley Ridge is that it is more than 200 feet below the surface of the Gulf of Mexico in U.S. territorial waters. During the last ice age (some 13,000 years ago), in what was called the early Holocene marine transgression, it was dry land. When sea levels started to rise, it retained its structure while being covered by water and is what geologists call today a drowned barrier island. What is unusual about this coral is that as sea levels rise, most corals grow upward to chase the sun for the most efficient photosynthesis. At Pulley Ridge, the coral has adapted in new ways not yet fully understood. The coral has grown thin and flat to catch the sun. Some scientists also think there may be alternate energy-gathering systems the zooxanthellae are employing to assist with the development of the corals at these depths. This is yet to be studied and verified. What is known is that this reef is almost 100 feet deeper than what was previously thought of as a viable environment for corals of this kind.



Coral Crisis

Not unlike a canary in a coalmine, coral is more susceptible to environmental impacts than other creatures (yes, coral is alive and a member of the animal kingdom) and is therefore a good predictor of wider environmental troubles. All over the world corals may be living their last days on Earth. Scientists agree that there are three major factors affecting coral health globally: climate changes, coastal pollution and development, and overfishing. These factors all combine to alter radically the ecosystem and compound the stresses on coral reefs. According to the Nature Conservancy, "Coral reefs are currently one of the most endangered ecosystems on the planet. If the present rate of destruction continues, 70 percent of the world's coral reefs will be killed within our lifetimes." In May of 2006, two coral species in Florida and the Caribbean—elkhorn (*Acropora palmata*) and staghorn (*Acropora cervicornis*)—were the first corals placed on the Federal Threatened List because of dangers posed by human activity, hurricanes, and higher water temperatures observed across the oceans. The elkhorn and staghorn coral species have suffered a 97 percent decline in areas off the Florida Keys and in the Caribbean since 1985.

This chain of drowned barrier islands, now a living coral reef, has a range of almost 125 miles at depths from 200 to 300 feet. It is located on the Florida shelf in the southeastern Gulf of Mexico, about 100 miles west of Key West, Florida. Scientists attribute three factors to the existence of the amazing formation. The elevated topography and lithified substrate are a perfect base for the hard-bottom coral community to take hold. The Loop Current of warm water, which comes north out between Mexico and Cuba and runs almost to the shores of Louisiana and then back down to join the Gulf Stream, supplies new coral larval recruits and warm, clean, and clear water to this unique system. Finally, the site is on the edge of the continental shelf, which drops thousands of feet, thus creating an upwelling of nutrient-rich waters that bathe the reef.

Left: Deep-water crinoids and green algae (*Anadyomene saldanhae*) share a home on Pulley Ridge.
Above: Video lights up the coral (*Ventricaria ventricosa*). When not lit by artificial light (as on our descent), these corals appear blue and purple.
Add the green of the algae, and Pulley Ridge looks like no other place on Earth.

The area was first discovered in the 1950s by a malacologist (someone who studies shells and mollusks) named Thomas Pulley, who gave the area its name. While collecting some deepwater benthic samples, he came up with unexpected species of mollusks and bottom-dwelling life forms. Some 50 years later, Brett Jarrett, a graduate student from Florida State University (FSU) working from Dr. Pulley's notes, made this location a stop in his studies on sedimentation of the Gulf of Mexico. That same year, Sylvia Earle was underway with a National Geographic Sustainable Seas Project identifying possible dive locations for her *Deep Worker* submarine. The unusual bottom sample found by Brett was brought to Dr. Earle's attention at a Sustainable Seas planning meeting. From that fateful day in 1999 to the summer of 2005, the United States Geological Survey (USGS) and FSU made yearly trips to the reef, using remote sensory equipment to map and sample this unique find. Dr. Earle was able to deploy *Deep Worker* as part of her larger Sustainable Seas project, but because of the reef's low-profile carpet of corals, close-up observation of this ecosystem was all but impossible. In spite of the subsequent expeditions' highly scientific equipment, getting up close and personal with the corals required old-fashioned human diving, or perhaps better called new-fashioned diving in the form of closed-circuit rebreathers and mixed-gas diving.

Jim Culter, a Mote Marine Lab scientist, was given the job of gathering and training the team of divers on how to collect samples off the delicate bottom of Pulley Ridge. My team's responsibilities included the expedition support vessel, dive operations logistics, underwater video, and photographic documentation. On day one, while still 35 miles away from our first dive site, we received a message from the submarine-launching platform that the research vessel (R/V) *Suncoaster* had headed back to safe anchorage in the Dry Tortugas. The captain informed us that the currents were just too strong to launch the sub and that they were going to wait a day before trying again. With months of planning and at least a week of work getting off the dock, this was not the news we wanted to hear.

We had to make the difficult decision whether to follow the lead of the *Suncoaster* or go ahead and dive. Gathering the team together, I briefed them on a drift dive designed to use the strong current to our advantage: a technique that can be compared to dropping skydivers out of a plane. If they do not all jump at the same time, they might potentially land miles apart. By dropping the divers from the moving boat all at once, they can drop down and ascend as a team with their passageways being defined by the currents. One member carries a long line with a small grapnel hook at one end and a large orange buoy on the other. The captain can then follow the buoy and stand by during the several

How Reefs Form

Pulley Ridge is a hermatypic reef. The coral shares its space with micro algae called zooxanthellae that use photosynthesis to turn sunlight into energy and produce by-products of oxygen and carbon. The coral is able to use this waste product from the algae to build its skeletal structure and thus form vast geological formations, a process that has been going on for over 40 million years. Corals are like volcanoes and tropical rain forests combined, in that they build land mass as well as capture and store the extra carbon dioxide that contributes to global climate issues. In effect, our reefs and rain forests are carbon dioxide storage units or sinks. Since our atmosphere is made up of 20.7 percent oxygen and 79 percent nitrogen, just a small amount of excess carbon dioxide can contribute to a major climatic change. Healthy reefs are important!

Date Box:

1842: Darwin writes "On Distribution of Coral Reefs with Reference to the Theory of Their Formation."

1950: Marshall Islands: While drilling to test a nuclear bomb, the drill team hits bedrock and discovers that coral is around 40 million years old.

1996: Multiple kinds of zooxanthellae are isolated, each having different characteristics and possibly able to withstand different stress levels.

2005: The Pulley Ridge reef is first visited by divers.

2006: The first corals are placed on the federal threatened list. 2006: The USGS makes two proposals to resource managers for the designation of marine protected areas based on the geophysical and photographic data collected to date. As of this writing, Pulley Ridge is listed as "an area of particular environmental concern" where fishing gear that disturbs the bottom, along with anchoring, is restricted.

Left:. Large green algae covers the bottom, with only 3 to 5% of light penetrating the surface. This is like finding a rain forest in Antarctica.
Above: Divers must perform over an hour of decompression for 20 minutes of work on the bottom.

I briefed them on a drift dive designed to use the strong current to our advantage: a technique that can be compared to dropping skydivers out of a plane.

hours needed to perform the dive and the required time for decompression. The buoy is vital as a visual tracking system for our rebreather divers because they do not create the telltale bubbles of open-circuit divers. Fortunately, Pulley Ridge covers such a large bottom area that locating a precise drop site was not critical and simple GPS coordinates were enough to launch the first team.

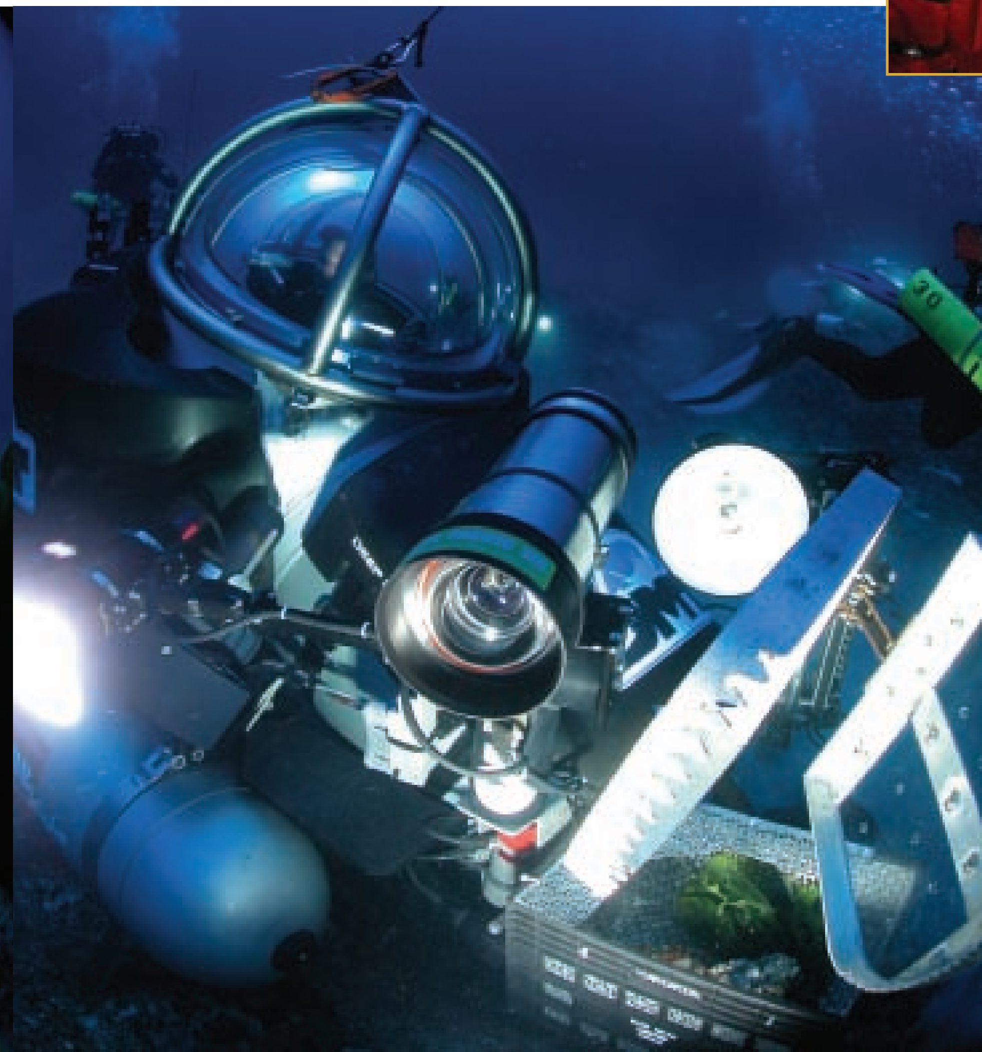
Descending to the bottom is something I will remember as long as I live. For 25 years, I have been diving and working on research projects in Florida and the Bahamas, as well as on Mexican and Cuban reefs. I have never seen anything like Pulley Ridge in all my time on the bottom of the ocean, including many thousands of dives from 30 to over 200 feet in depth. Among some of the unusual discoveries found here is an algae called *Anadyomene saldanhae*, a plant that is common in the 20-to-40-foot depth range. To find it growing at depths of 230 feet, where it receives only 5 percent of the sunlight that is normal at shallow depths, is phenomenal. Far from being an isolated occurrence, the large, brilliant green, meter-wide plant can be found carpeting the bottom of Pulley Ridge as far the eye can see. Could it have a role in supplying oxygen to the ecosystem, allowing the corals to grow? Those of us who saw its abundance firsthand called it a "cabbage patch" reef. This, more than anything else, gives Pulley Ridge a look that is unmistakable. Dr. Sylvia Earle noted, "If dropped on Pulley Ridge, with one look I could distinguish it from any other place on Earth. The blue-purple coral and giant green algae make this unique on the planet."

After two successful four-man team deployments, and the collection of unique samples and close-up photographs, we all shared a sense of accomplishment. The ride back to anchorage at the Tortugas was surreal as we basked in this historic moment in time as the first divers to touch down on Pulley Ridge. It was not until later, however, while showing my photographs to the scientists, that we realized we had captured the imagery and samples that had proven elusive to all others for the past five years. The success of the divers was best summed up by Billy Causey, U.S. South Eastern Regional Sanctuaries manager, when he said, "This was possibly the most comprehensive and focused assessment of a deep-water coral reef environment ever undertaken."

Is this deep reef a link to a past healthy reef system? Can it and others like it be the refuge for the future recovery of coral reefs? Will they help us to understand what is truly happening to corals around the world today? I believe the answer to these questions is yes, and this is why I refer to Pulley Ridge as Hope's Reef. This and future discoveries will help us find the key to long-term sustainability of the corals and their symbiotic ecosystems that can save our shallow-water corals. ■

TIM TAYLOR *is the discoverer of Sherwood Forest, considered the centerpiece of the Tortugas Ecological Reserve and one of the healthiest reefs in the Caribbean. Over the past ten years and particularly in the last 18 months, he has supervised coral research expeditions aboard his research vessel R/V Tiburon. He has worked with Scripps Institute of Oceanography, Mote Marine Lab, United States Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), University of Texas, Nova University, National Park Service (NPS), Harte Research Institute, Florida State University (FSU), and the University of Miami to understand what coral was once like and what is happening to our reefs today. He is currently employing trimix closed-circuit rebreathers and high-definition imaging to enhance these research projects. He co-owns and operates Aquatic Films Inc., Research Vessel Tiburon, Inc., and is director of Ocean Outreach. This nonprofit organization was formed to develop multimedia real-life expedition content, children's books, and educational materials. For more information visit www.oceanoutreach.org, www.rvtiburon.com, and www.aquatic films.com.*

Above: Due to its low profile, Pulley Ridge has been overlooked for years. It took divers to get up close and personal and bring home the images that show you what an amazing and beautiful ecosystem this is.



Above: In a historical underwater meeting, Dr. Sylvia Earle in her *Deep Worker* submersible meets up with our dive team on a sampling dive. Above right: Jim Culter was the lead scientist from Mote who trained and led the tech diving team.

Diving Deeper

The ability to take the study of coral to new depths is made possible by mixed-gas diving and, more recently, closed-circuit rebreathers. As opposed to open-circuit scuba gear, rebreathers recover exhaled oxygen and absorb carbon dioxide, which makes far longer dives possible. They also reduce the amounts of inert gases in the breathing mix, so decompression requirements are minimal. This equipment is cautiously finding its way into the research field from the cave and deep wreck–diving communities. Although slow to be accepted, the future use of this form of advanced technical diving is clear. It allows an expedition team such as mine to accomplish the same tasks today that would have taken ten times the equipment and manpower to do a decade ago. On this expedition, the *Deep Worker* submarine was able to log 21 hours of observable bottom time compared to our team of divers who logged 18.5 hours* and we (the divers) were better equipped to collect some of the more delicate samples from the reef floor. What will happen to ocean studies when these tools find their way into the hands of scientists and trained naturalists? The possible discoveries are endless.

**This is bottom time and does not include the obligatory hours of decompression associated with the dive plan.*