Battle for the Deep Seafloor

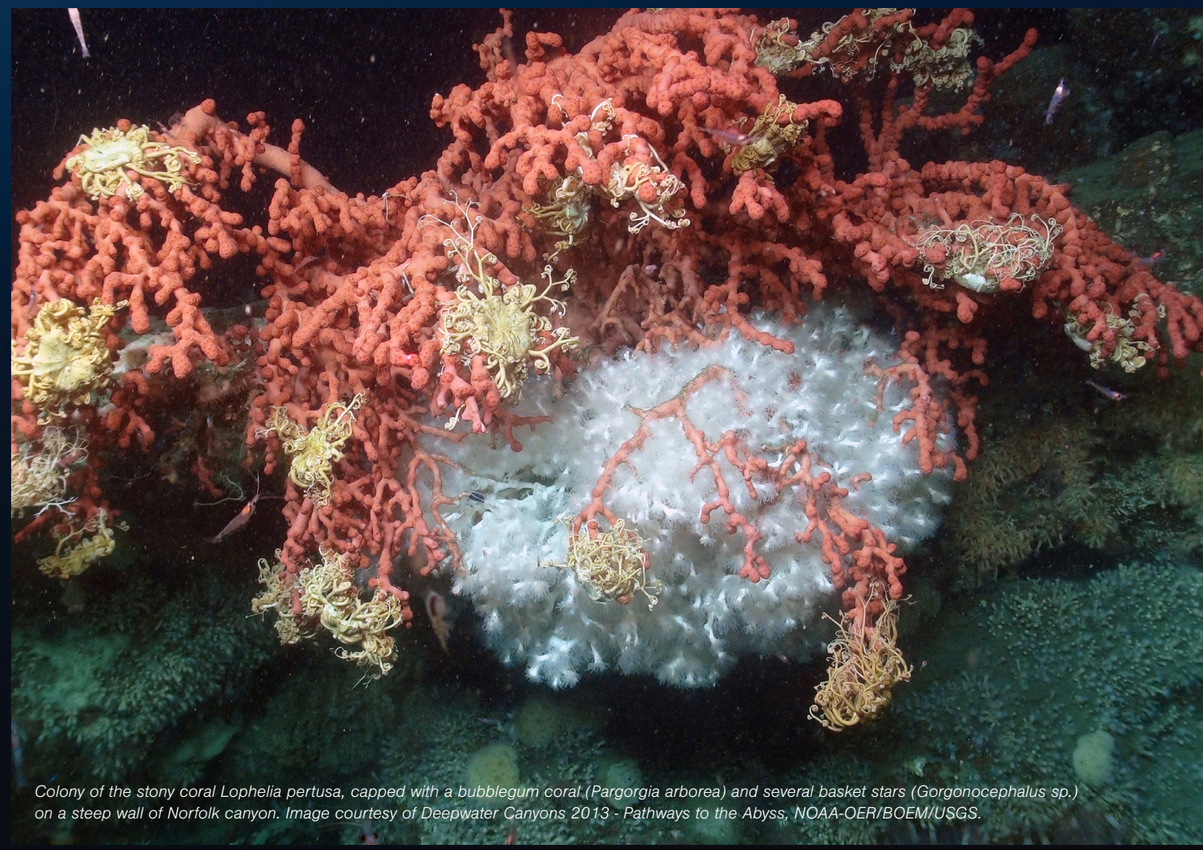
Words by Sandra Brooke, Florida State University Coastal and Marine Lab

Human interest in the marine environment originally focused on the highly productive coastal zone, where food and energy resources were readily available. The deep sea was left in relative peace. Over time, we began to use up our coastal resources and started looking further offshore for unexploited fish stocks and oil reserves. This industry migration precipitated the need to understand the distribution and sensitivities of deep-sea ecosystems to prevent damage from human activities.

In the United States, fisheries and mineral reserves in federal waters are managed by the National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Ocean Energy Management (BOEM) respectively. Although their management objectives are distinct, these agencies often collaborate together, and with other entities, to explore and study deep-sea ecosystems. Information generated through these efforts is used to inform management practices.

Since the 1980s, scientists have used submersibles and Remotely Operated Vehicles (ROVs) to study the extensive areas of deep-sea coral reefs in the US southeast region. Deep reefs perform many similar functions to their shallow-water counterparts; stony corals construct the complex reef framework, which provides habitat for diverse and abundant communities of invertebrates and fishes, some of which are economically important. Industrial bottom trawling for these valuable fish stocks has caused severe damage to many deep reefs. Since deep corals are very slow-growing and long-lived, ecosystem recovery could take centuries, if it happens at all. In the southeast region, most of the known deep coral habitat was protected from bottom-tending fishing gear in 2009, through the establishment of deep coral Habitat Areas of Particular Concern (HAPC); however vast areas of the Blake Plateau, a massive carbonate platform that dominates the southeast region, remains unmapped and unexplored.

In anticipation of energy lease sales off the Mid-Atlantic region of the US, BOEM, NOAA and the US Geological Survey (USGS) funded the Atlantic Deepwater Canyons project to characterize the physical environment and biological communities within submarine canyons along the deep slope. This study documented dense communities of deep-sea corals, and associated fauna along the current-swept canyon walls, and these rugged habitats were de-facto refuges for commercial fisheries species that are harvested heavily on the adjacent muddy slope. This study and additional expeditions by the NOAA Office of Ocean Exploration contributed to the establishment of a Deep Coral Protection Area that extended from New York to North Carolina. The information and stunning images generated by these efforts also led to the Atlantic energy lease sales being closed, and the establishment of the first Atlantic Marine National Monument to further protect these ecosystems.



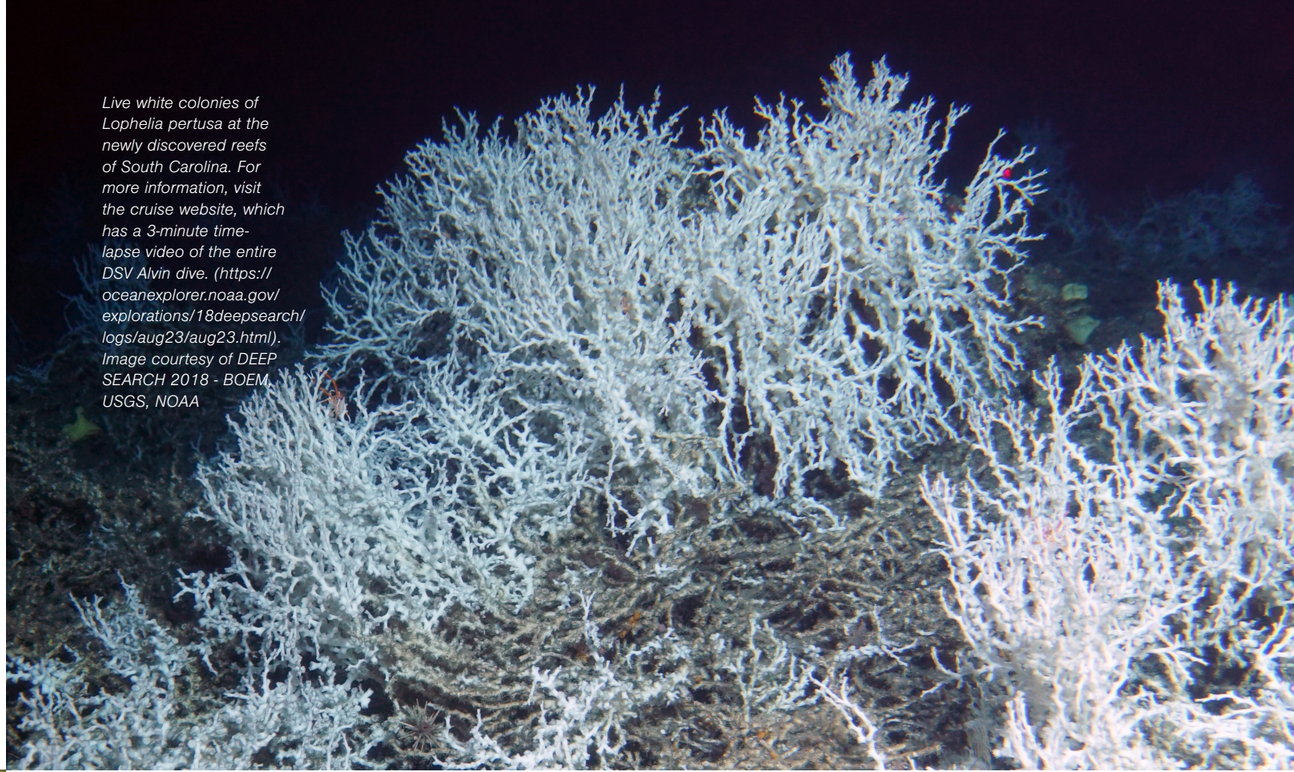
Colony of the stony coral Lophelia pertusa, capped with a bubblegum coral (Pargorgia arborea) and several basket stars (Gorgonocephalus sp.) on a steep wall of Norfolk canyon. Image courtesy of Deepwater Canyons 2013 - Pathways to the Abyss, NOAA-OER/BOEM/USGS.

In 2011-2013, acoustic mapping surveys identified extensive gas venting along the western Atlantic margin from 50-2000 meters. Of the 500 or more bubble plumes documented, only a few have been explored; however, visual surveys of these sites showed vast zones of dense chemosynthetic communities and other seep-endemic fauna, abundant gas hydrate deposits, and rugged regions of authigenic carbonate. These ecosystems were unexpected and previously undiscovered; just offshore of one of the most populated coasts in the US.

In 2016, BOEM, NOAA, and the USGS initiated a 4.5-year, multi-disciplinary project called Deep SEARCH. This study focuses on submarine canyons, gas seeps and deep coral habitats between Virginia and North Florida. The overarching goal of the Deep SEARCH project is to explore and survey target habitats, understand the sensitivity of their associated biological communities to natural and human disturbances, and generate models that will help predict the distribution of these ecologically important ecosystems.

Earlier this year, the NOAA Ship *Okeanos Explorer* conducted acoustic mapping and ROV operations in the southeast region in collaboration with the Deep-SEARCH team and other scientists. New seafloor maps revealed a seemingly endless expanse of mound-like features off Florida, aptly named 'Million Mounds'. The ROV conducted dives on two of these mounds, and both were thriving deep-sea coral reefs, constructed by the stony corals *Lophelia pertusa* and *Enallopsammia profund*a (which is endemic to the western Atlantic). If all those mounds are live reefs, this could be the most extensive coral province in the north Atlantic. In another area, about 250 kilometers off South Carolina, was a complex series of ridges that extended for about 140 kilometers. An ROV dive near this area showed diverse assemblages of corals and sponges, some of which have rarely been observed in the southeast region. Strong currents generated by the Gulf Stream prevented any ROV dives on the main ridge complex, but the limited peek at the seafloor showed that these features certainly warranted further exploration.

Authigenic carbonate boulders covered with thousands of chemosynthetic mussels (Bathymodoilus sp.)at Norfolk seep. This is one of the largest known methane seeps, at nearly 2 kilometers in length and was only discovered in 2013. Image courtesy of Deepwater Canyons 2013 - Pathways to the Abyss, NOAA-OER/BOEM/USGS.



Live white colonies of Lophelia pertusa at the newly discovered reefs of South Carolina. For more information, visit the cruise website, which has a 3-minute time-lapse video of the entire DSV Alvin dive. (https://oceanexplorer.noaa.gov/explorations/18deepsearch/logs/aug23/aug23.html). Image courtesy of DEEP SEARCH 2018 - BOEM, USGS, NOAA

A short time after the NOAA Ship *Okeanos Explorer* returned home, the Deep SEARCH team left Woods Hole Oceanographic Institution aboard the R/V *Atlantis*, with the Deep Submergence Vehicle (DSV) *Alvin*. One of the expedition objectives was to dive on the new ridge system mapped by the *Okeanos*. Two *Alvin* dives confirmed the presence of spectacular coral reefs at 700-850 meters, with fields of live *Lophelia* so dense in places that they obscured the seafloor. The presence of *Lophelia* mounds in the southeast region is not unusual; however, at 800 meters the reefs are commonly composed primarily of dead coral framework rather than the abundance of live coral observed in these 'new' reefs. The water column environmental profile was also highly unusual, with a much higher temperature than expected for these depths. It is unclear whether this is a permanent condition, or a short-term event driven by Gulf Stream meanders. In either case, this newly discovered reef system presents a fascinating natural laboratory to study the effects of warming events on deep coral ecosystems.

Over the past five years, deep–sea exploration of the US east coast has revealed hundreds of potential chemosynthetic ecosystems, dense and diverse communities in submarine canyons, and vast areas of deep coral habitat, and there is plenty of seafloor in this complex region still to be mapped and explored. These ecological treasures also harbor valuable commercial resources such as fisheries species, and energy and mineral reserves, which create potential conflicts between exploitation and conservation. Wealthy nations such as the USA have the financial resources to map and study the deep sea, and the legislative infrastructure to manage and protect their marine ecosystems. Many other nations are not so fortunate, and for the High Seas (areas beyond national jurisdiction), the logistical and legal challenges of discovery and regulation seem almost insurmountable. Unregulated exploitation in some areas has caused severe damage to resources that could have been managed sustainably.

In addition to traditional deep-sea industries such as fishing and fossil fuel extraction, new threats have emerged in recent years. The global explosion in the use of electronic devices has created a demand for metals such as copper and cobalt. This demand has resulted in vast areas of the deep sea – within and outside national boundaries – being leased for mineral extraction. Seamounts are targeted for cobalt, hydrothermal vents for rare metals, and polymetallic nodule fields for manganese. Without the information and infrastructure to establish sustainable management practices, ancient ecosystems will be sacrificed for short-term gain.

There has always been a battle between conservation and exploitation, but in this era of ever-increasing demands on our wild places, who will ultimately win, and lose, remains to be seen.