



New Frontiers in Ocean Exploration

The E/V *Nautilus*, NOAA Ship *Okeanos Explorer*,
and R/V *Falkor* 2019 Field Season

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Oceanography

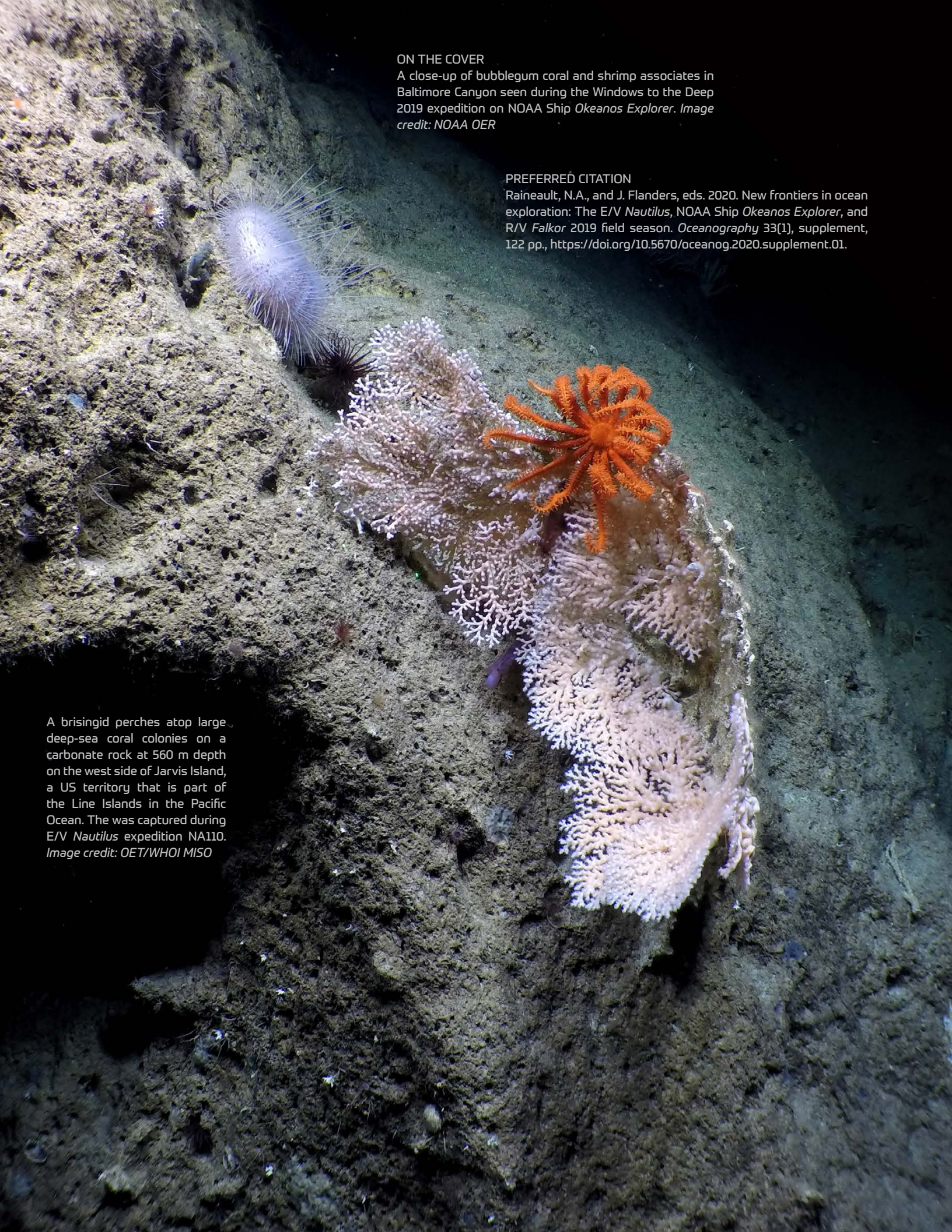
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ON THE COVER

A close-up of bubblegum coral and shrimp associates in Baltimore Canyon seen during the Windows to the Deep 2019 expedition on NOAA Ship *Okeanos Explorer*. Image credit: NOAA OER

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A brisingid perches atop large deep-sea coral colonies on a carbonate rock at 560 m depth on the west side of Jarvis Island, a US territory that is part of the Line Islands in the Pacific Ocean. The was captured during E/V *Nautilus* expedition NA110. Image credit: OET/WHOI MISO

DEEP SEARCH Project Completes Last Year of Fieldwork with Two Successful Expeditions

By Erik Cordes, Amanda Demopoulos, Michael Rasser, and Caitlin Adams

In 2019, the Deep Sea Exploration to Advance Research on Coral/Canyon/Cold seep Habitats (DEEP SEARCH) project completed its third and final field season with two successful expeditions aboard NOAA Ships *Ronald H. Brown* and *Nancy Foster*.

A MULTIYEAR, MULTIAGENCY STUDY

Funded by the Bureau of Ocean Energy Management (BOEM), the US Geological Survey (USGS), and NOAA's Office of Ocean Exploration and Research, DEEP SEARCH is a multiyear, interdisciplinary study to explore and characterize sensitive deep-sea habitats—submarine canyons and methane seeps—and deep-sea coral communities in the US south and mid-Atlantic. The project is managed by TDI-Brooks International, and principal investigators include scientists from six US academic institutions, one non-US academic institution, and five USGS science centers.

The project study area encompasses the majority of the BOEM Mid-Atlantic and South Atlantic Outer Continental Shelf planning areas, spanning deepwater offshore areas

from Virginia to Georgia. With such a large study area, the field research program was designed to be comprehensive, utilizing multiple platforms and technologies. In 2017, NOAA Ship *Pisces* deployed AUV *Sentry* in the area to generate initial maps of potential study sites. In 2018, NOAA Ship *Okeanos Explorer* added significant multibeam bathymetry coverage, which was then used to plan an R/V *Atlantis* expedition with HOV *Alvin* and choose a site for deployment of two benthic landers from R/V *Brooks McCall*.

In 2019, the DEEP SEARCH team completed the program's final and most intensive field season, with a spring expedition on NOAA Ship *Ronald H. Brown* with ROV *Jason* and a fall expedition on NOAA Ship *Nancy Foster*. Both expeditions returned to sites identified by the earlier missions and significantly expanded our knowledge of the US southeastern continental margin.

NOAA SHIP RONALD H. BROWN EXPEDITION

From April 9 to 30, 2019, the DEEP SEARCH team conducted a research expedition on *Ronald H. Brown* with ROV *Jason*. Eleven dives, ranging in duration from four to 24 hours, were completed at one canyon, four seeps, and five coral sites from 200 m to 2,600 m depth (Figure 1). An additional 6,733 km² of multibeam bathymetry were acquired, and more than 1,600 biological and geological samples were collected with the ROV, by CTD, and with a monocoire.

The team continued work at the Richardson Hills reef complex first characterized in 2018 and explored new sites to verify coral habitat prediction models. A benthic lander from the Royal Netherlands Institute for Sea Research was redeployed at Richardson Hills to collect long-term environmental data on the coral habitat (Figure 2). A sharp

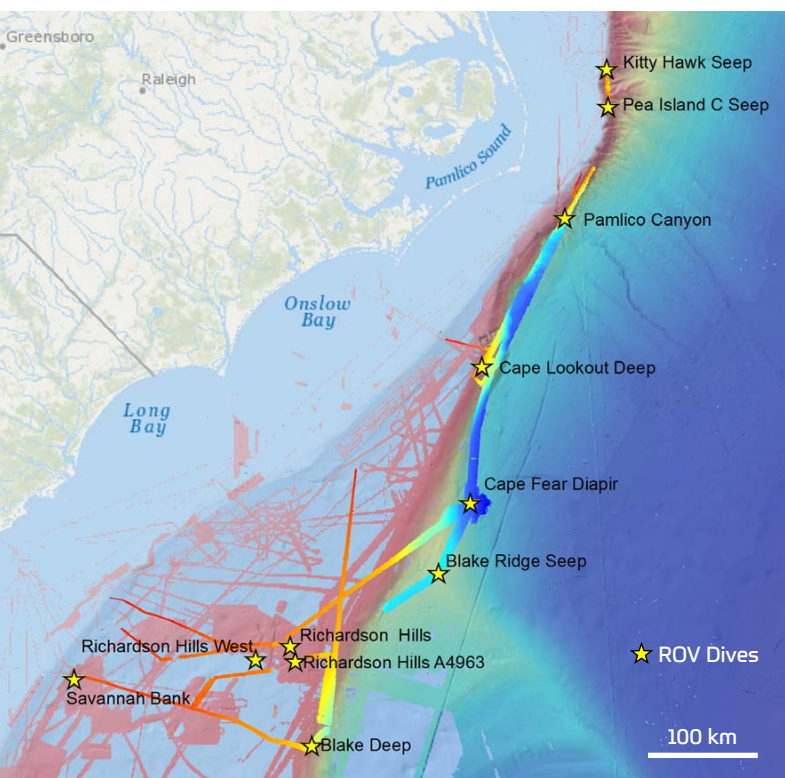


FIGURE 1. Map showing the DEEP SEARCH study area, with multibeam mapping data collected by NOAA Ship *Ronald H. Brown* overlaid on existing bathymetry coverage. ROV *Jason* dive sites are indicated by yellow stars. Image credit: USGS

FIGURE 2. The deck crew of NOAA Ship *Ronald H. Brown* launches the Netherlands Institute for Sea Research benthic lander for a long-term seafloor deployment near the coral mounds of Richardson Hills. Image credit: DEEP SEARCH 2019 - BOEM, USGS, NOAA

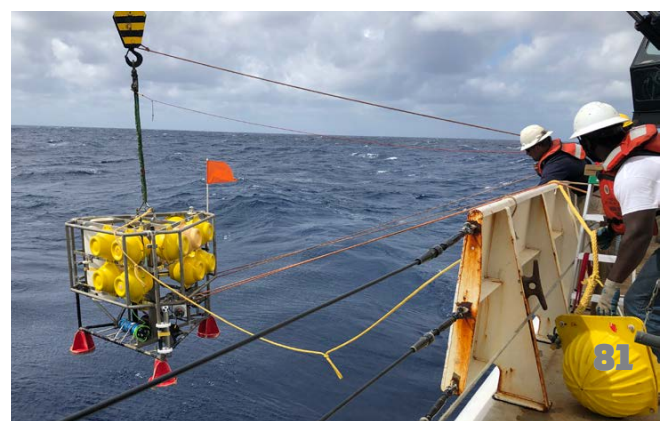




FIGURE 3. At Pamlico Canyon, canyon walls were covered in brisingid starfish and a diversity of octocorals and stony corals. Image credit: Ivan Hurzeler, BOEM, USGS, NOAA, ROV Jason, ©WHOI

FIGURE 4. At Pea Island Seep, the team observed a small colony of *Lophelia pertusa* that had settled on carbonate rock and that attracted abundant fish. Image credit: Ivan Hurzeler, BOEM, USGS, NOAA, ROV Jason, ©WHOI



thermocline was observed at the Richardson Hills site at the same depths as the highest cover of live corals, suggesting the presence of internal waves that can influence food supply and nutrients available to the corals.

The dive within Pamlico Canyon revealed eroded walls with sculpted outcrops and sharp overhangs covered in cup corals and octocoral sea fans that create habitat for a variety of fishes and octopuses (Figure 3). The benthic lander deployed at the site in October 2018 remained in place and continued to collect data about the current dynamics and other characteristics of this complex system.

At the northern extent of the study region, the team explored two recently discovered seeps (~300 m depth) and found that they are more complex and dynamic systems than previously understood. The carbonates produced as a byproduct of methane oxidation provide hard substrate for deepwater coral settlement, which in turn increases the complexity of the habitat that harbors a diverse fish assemblage (Figure 4). Vestimentiferan tubeworms, which had never been observed in this part of the Atlantic before, were discovered at both Kitty Hawk and Pea Island seeps. Two deeper seeps at Blake Ridge and Cape Fear were sampled intensively and will provide a good comparison with the shallower seeps.

NOAA SHIP NANCY FOSTER EXPEDITION

In October 2019, the DEEP SEARCH team spent nine days at sea on *Nancy Foster* to complete the last major fieldwork of the project. The benthic lander deployed at Richardson Hills was successfully recovered, bringing with it nearly seven months of environmental sensor, acoustic, and video data. Water sampled at four sites will be used to assess water chemistry, microbial and metazoan diversity, and environmental DNA. Midwater trawling of the deep scattering layer was accomplished at Blake Ridge Seep, Pamlico Canyon, and Richardson Hills. The data from these trawls will be used to examine the ecological interactions between the seafloor and the water column.

ANALYSIS UNDERWAY

With three years of fieldwork complete and thousands of samples now back at more than 10 research labs, the DEEP SEARCH team will continue to analyze data and develop a final report through 2021. The results of this study will be used to further understanding of these sensitive deepwater habitats and help BOEM make informed management decisions.