Prospective Deep Sea Coral Habitats on Musicians Seamounts, Pacific Ocean

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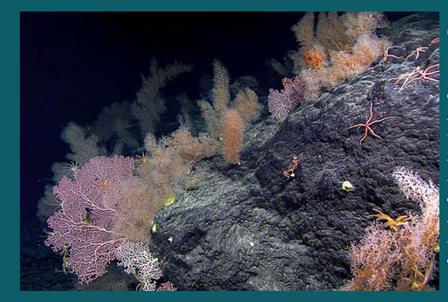
ABSTRACT

Deep sea corals thrive in areas of high slope, hard substrate, and exist at depths ranging 400 to at least 2100 m. In August 2017, NOAA's Deep-Sea Symphony expedition mapped Musicians Seamounts and collected video footage of the diversity of corals found there. Multibeam sonar and backscatter intensity data were collected aboard NOAA Ship *Okeanos Explorer*, and were then post-processed in CARIS HIPS & SIPS 10.4. Bathymetry, backscatter mosaics, and profiles were used to find sites of high slope and high backscatter intensity, in order to identify potential coral habitat locations. ROV dives to these sites should be conducted

BACKGROUND

Cold water corals, also known as deep sea corals, are communal organisms living in a calcareous structure that is attached to hard substrate. They thrive in oceanic depths of 400 to at least 2100 m (Etnoyer et al., 2011 and 2015), and benthic environments that have both moderate to high slope and hard substrate are preferable habitat for deep sea coral. High slope areas have strong currents, which bring oxygen and food down to the seafloor and increase biological processes, allowing for coral growth. These corals are known to find habitat in geologically high relief, where productivity is high and sediment burial does not interfere with coral polyp development. These cold water corals are not found in abundance on continental shelves or homogeneous slopes, however, they are often found many submarine canyons on the continental slope (Freiwald et al., 2004) or on the flanks of seamounts (Etnoyer, 2010). Until recently, scientists did not have extensive knowledge of deep sea coral diversity. With improvements in multibeam sonar and backscatter processing, hydrographers have been able to locate steep, hard-bottom areas on the ocean floor that are thought to be the ideal habitat for deep sea corals.

The purpose of this study is to use bathymetric profiles and backscatter intensity to locate areas of both high slope and hard substrate to find potential deep sea coral habitats, where a Remotely Operated Vehicle (ROV) could be sent to search for and further study deep sea corals.



Coral diversity found on Sibelius Seamount. *Image courtesy of the NOAA Office of Ocean Exploration and Research, Deep-Sea Symphony: Exploring the Musicians Seamounts.*

METHODS

- Multibeam sonar data were collected by NOAA's Office of Ocean Exploration and Research (OER) on board NOAA's *Okeanos Explorer*, using a Kongsberg EM302 echosounder.
- CARIS HIPS & SIPS 10.4 was used to process raw data and create a CUBE BASE surface, with a 30 m resolution.
- A slope surface and a SIPS Mosaic Backscatter surface were rendered at 30 m resolution.
- Profiles of depth and backscatter were created along the elongate part of each seamount.
- Profiles were compared and areas with the highest intensity backscatter return and the greatest slopes (slopes of 15 degrees or higher) were identified. Slopes with high intensity were measured using HIPS.

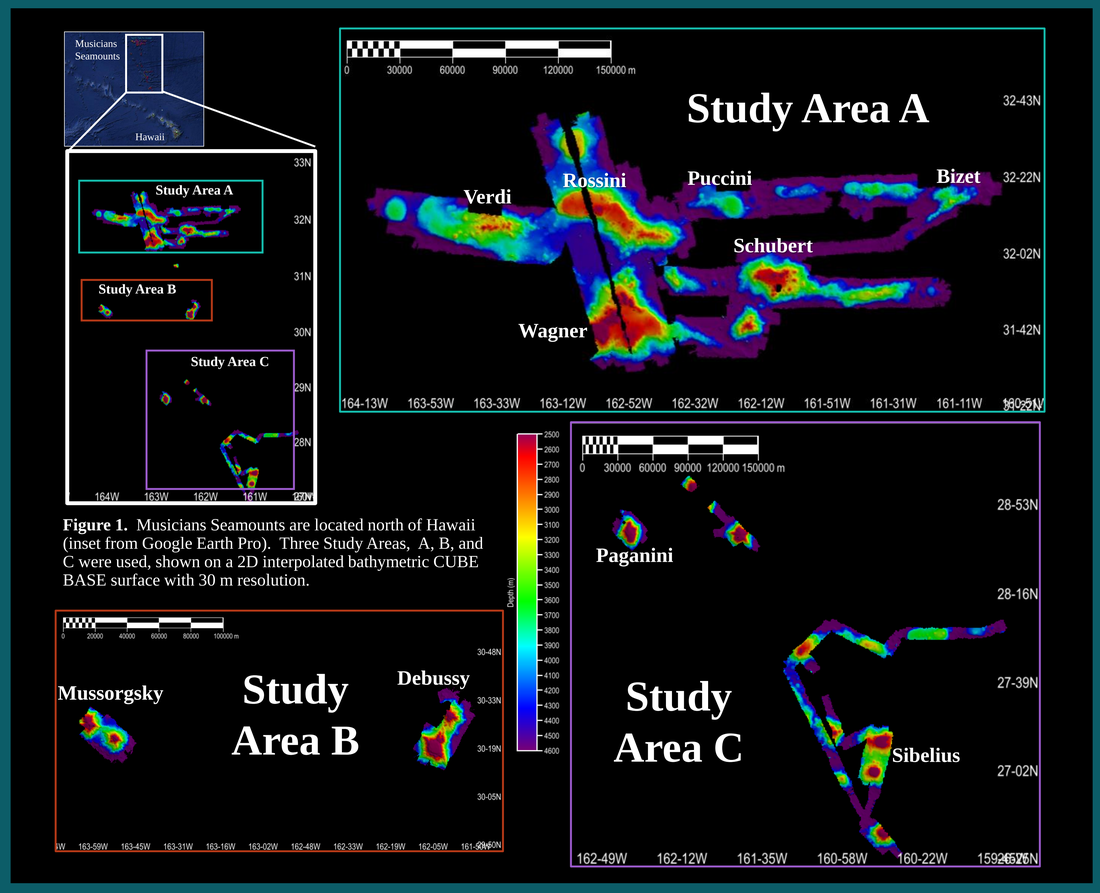


Figure 1. Musicians Seamounts are located north of Hawaii (inset from Google Earth Pro). Three Study Areas, A, B, and C were used, shown on a 2D interpolated bathymetric CUBE BASE surface with 30 m resolution.

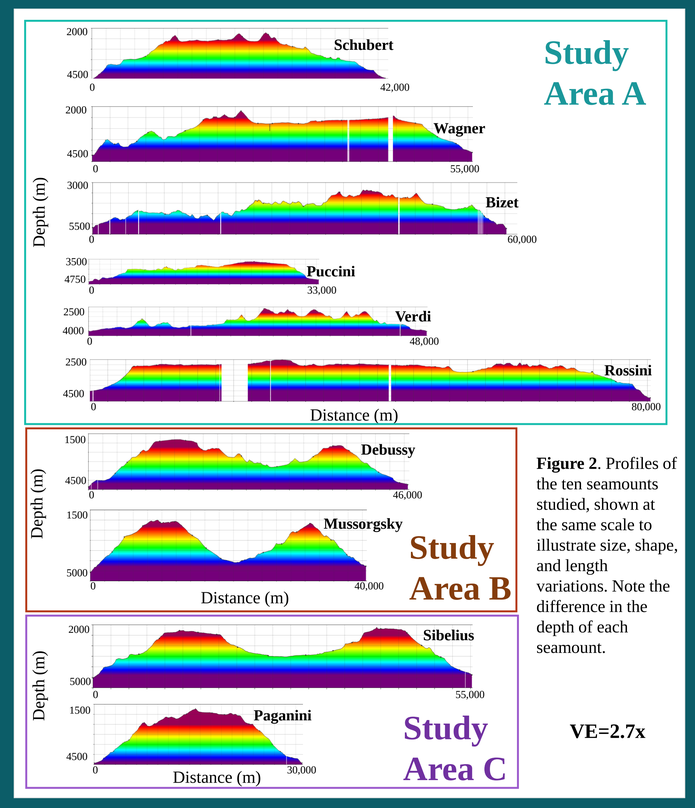


Figure 2. Profiles of the ten seamounts studied, shown at the same scale to illustrate size, shape, and length variations. Note the difference in the depth of each seamount.

VE=2.7x

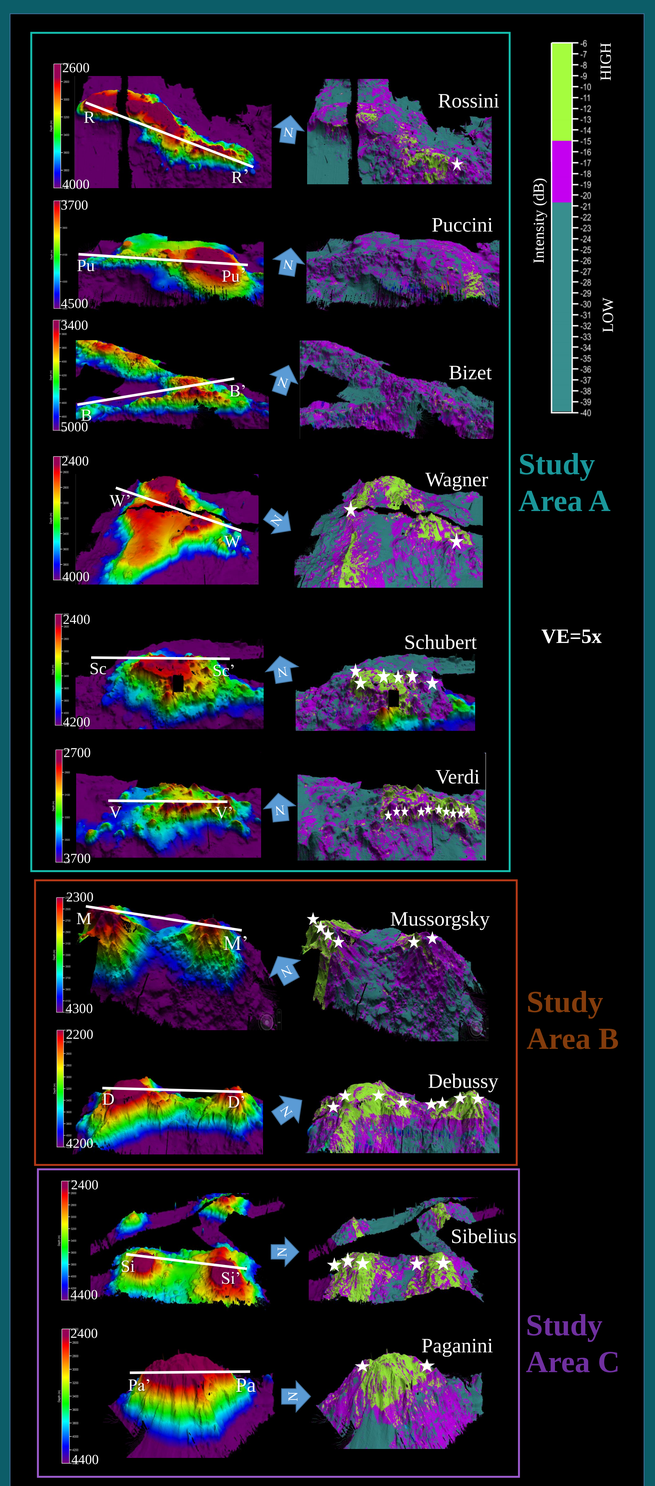


Figure 4. 3D images of both depth and backscatter intensity draped over the depth layer. The white lines on the depth layer show the profile lines (Figure 2). The white stars are located on the target sites, or the areas that had high slope and high backscatter intensity along each profile line. (see Figure 3). Note that no sites are present on Bizet or Puccini Seamounts, while Verdi Seamount has the most sites.

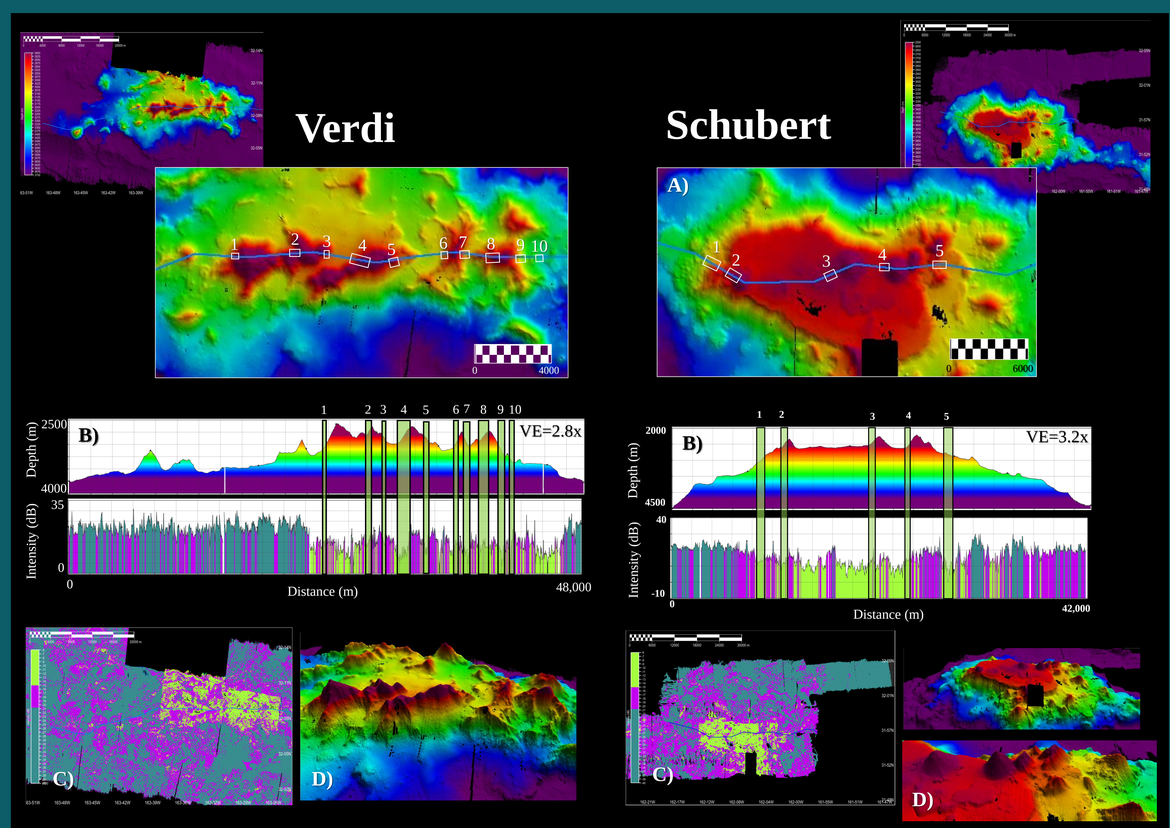


Figure 3. Examples of two seamounts examined, illustrating methods for identifying Deep Sea Coral habitat locations. (A) Profile line displayed on a CUBE bathymetric surface, showing points along the line which are potential coral habitat locations. (B) Profiles of depth and backscatter intensity, showing sites of accordance between high slope and high backscatter intensity. Note that areas of high backscatter intensity do not always correlate with high slope areas, and vice versa. (C) Backscatter mosaic with overlain profile line. (D) 3D image of the seamount.

Table 1. Example tables of slope values measured in CARIS for Verdi and Schubert Seamounts.

Verdi Seamount

Site	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
Slope	18.0	24.8	23.5	19.6	19.7	23.0	26.2	16.1	23.7	21.9

Schubert Seamount

Site	S1	S2	S3	S4	S5
Slope	19.3	20.2	17.2	19.1	15.1

RESULTS

- A total of 40 potential deep coral habitat sites were identified along the 10 seamount profiles.
- Backscatter intensity along the profiles ranged from -6 to -15 dB.
- Profile areas of high backscatter had slopes that ranged from 15.1 to 29.8º.
- There were many areas of high backscatter intensity in the range of -6 to -15 dB that had slopes out of the high slope 15.1-29.8º range (see methods), meaning that high slope does not always correlate hard bottom substrate.
- Verdi Seamount had the most deep coral habitat sites (10 sites), with slopes ranging from 16.1 to 26.2º. Some of these sites were deeper than 3000 m, beyond the proposed habitat depth range.

Primnoid octocorals (*Paracalyptrophora* sp.) found on Paganini Seamount. *Image courtesy of the NOAA Office of Ocean Exploration and Research, Deep-Sea Symphony: Exploring the Musicians Seamounts.*

DISCUSSION and CONCLUSIONS

Each seamount in the Musicians chain varies morphologically, with some exhibiting flat tops and some are more peaked. (Fig. 2). The deep sea coral research of NOAA's Musicians Seamounts expedition can be used to better understand the relationship between high slope and high backscatter intensity. According to the Deep Sea Symphony daily log, Musicians Seamounts had a high abundance and high diversity of deep sea corals. These corals were found at depths between 1800 and 3000 m (NOAA, 2017).

Many results from habitat sites identified in this study using the bathymetric and backscatter data are comparable to visual observations made during NOAA's Musicians Seamounts expedition using a video camera mounted on a remotely operated vehicle (ROV). Notably, the two seamounts examined that had no target habitat sites (Puccini and Bizet Seamounts) also had no observed corals during the expedition (NOAA, 2017). Verdi Seamount, the seamount with the most target habitat sites identified in this study, had many corals visually documented on its high slopes. In contrast to results of this study, both Mussorgsky and Debussy Seamounts had more than 5 sites of potential habitat, yet NOAA reported that corals were not found in similar areas. Rather, corals observed on these two seamounts were found on the flat summit of Mussorgsky, and on the very low slope areas of Debussy.

Overall, the NOAA expedition scientists concluded that corals on Musicians seamounts were found in areas of previous submarine eruptions: on sheet, lobate, and pillow flows (NOAA, 2017). Further work and ground-truthing would need to be conducted to test the reliability of this study's methods in locating deep sea coral habitat. Locating coral habitat is critical in order to protect these slow-growing deep sea organisms from threats, such as trawling or coral mining.

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