Using Multibeam Sonar to Identify Potential Deep Sea Coral Habitat on Northwest Hawaiian Island Seamounts

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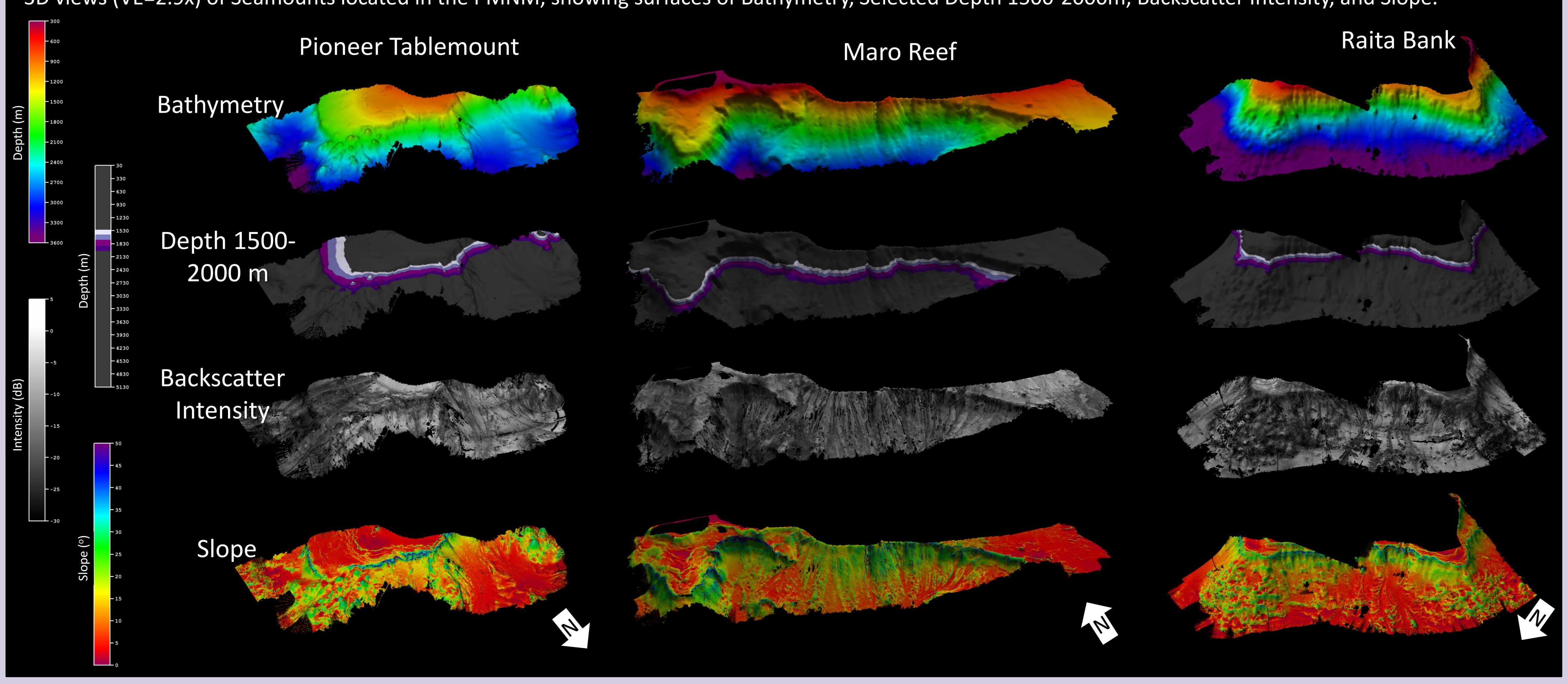
Abstract

In 2016, the Obama Administration expanded the Papahānaumokuākea National Monument, located in the Northwestern Hawaiian Islands which includes numerous seamounts. Seamounts are of particular interest as they can serve as habitat and nursery areas for deep corals and sponges. Studying deep sea corals is important, as they provide habitat and shelter for many organisms, increasing deep sea biodiversity. During the early summer of 2014, Dr. Christopher Kelley led a bathymetric survey of this area to identify important structures for research of deep sea corals, fish and other animal habitats. Multibeam sonar and backscatter intensity data were collected on the Schmidt Ocean Institute's *R/V Falkor*, and were post-processed in CARIS HIPS and SIPS 9.1. Bathymetry, slope and backscatter intensity surfaces were used to determine which areas would be ideal for deep coral habitat, such as high slope areas with hard substrate. Three study sites within the National Monument were selected, including Pioneer Tablemount, Maro Reef and Raita Bank. Each site was subdivided for comparison of depth, slope and backscatter intensity. Transect profiles were created for data collection at 1500, 1625, 1750, 1875 and 2000 m contours, where slope and backscatter intensity values were compared across. High intensity areas did not correlate with high slope, as predicted. Additional research should be conducted to examine areas of similar slope to aid in the identification of potential deep-sea coral habitats.

FIGURE 2

3D views (VE=2.9x) of Seamounts located in the PMNM, showing surfaces of Bathymetry, Selected Depth 1500-2000m, Backscatter Intensity, and Slope.



Methods

Multibeam sonar bathymetry and backscatter intensity data were collected by Dr. Christopher Kelley as part of the UNOLS R2R program, on board the Schmidt Ocean Institute's R/V *Falkor (Cruise* FK140502) in May-June 2014 using a Kongsberg EM302 and EM710. Data were post-processed in CARIS HIPS and SIPS 9.1 to make a 30m CUBE BASE and slope surfaces for analysis. Backscatter intensity data were classified and used to determine which areas would have hard substrate, and would likely be ideal for deep coral habitat. Each Study site was divided into three morphologically similar sections for comparison of Slope and Intensity at depths 1500, 1625 ,1750, 1875 and 2000 m along profile transects A-I (Fig. 3, Table 1).

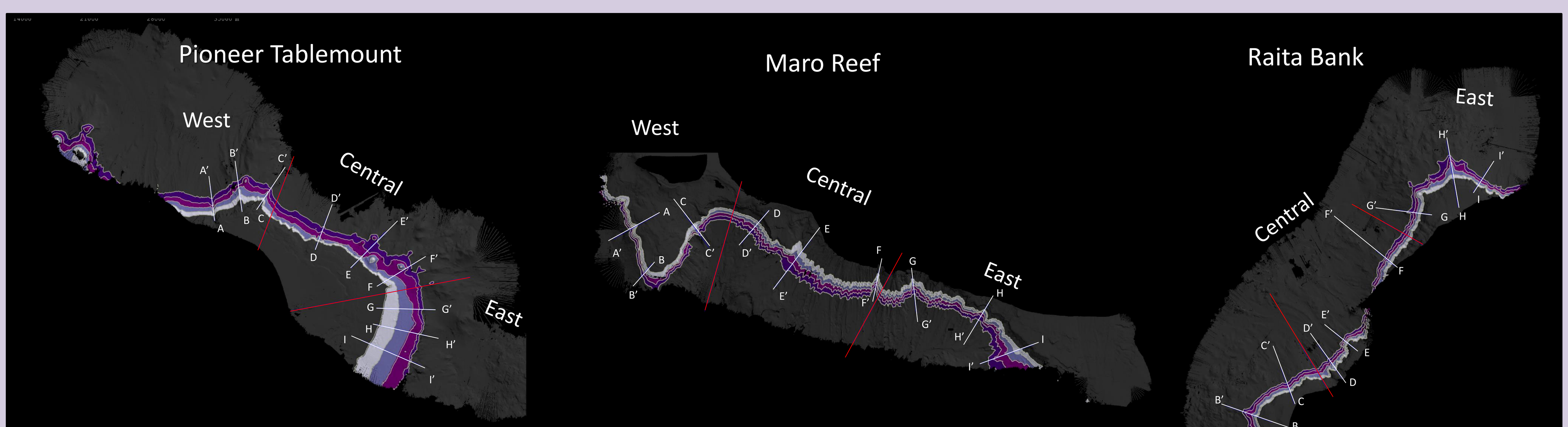


FIGURE 3: Profile transects of Pioneer Tablemount, Maro Reef and Raita Bank for data on/near 1500, 1625 ,1750, 1875 and 2000 m contours. Each Study site was divided into morphologically similar sections for comparison of Depth, Slope and Intensity (Table 1).

FIGURE 5: Representative profiles along transect lines for each study area. All profiles show the seamount flanks and are sized to the same scale, with a vertical exaggeration of 2.5x.

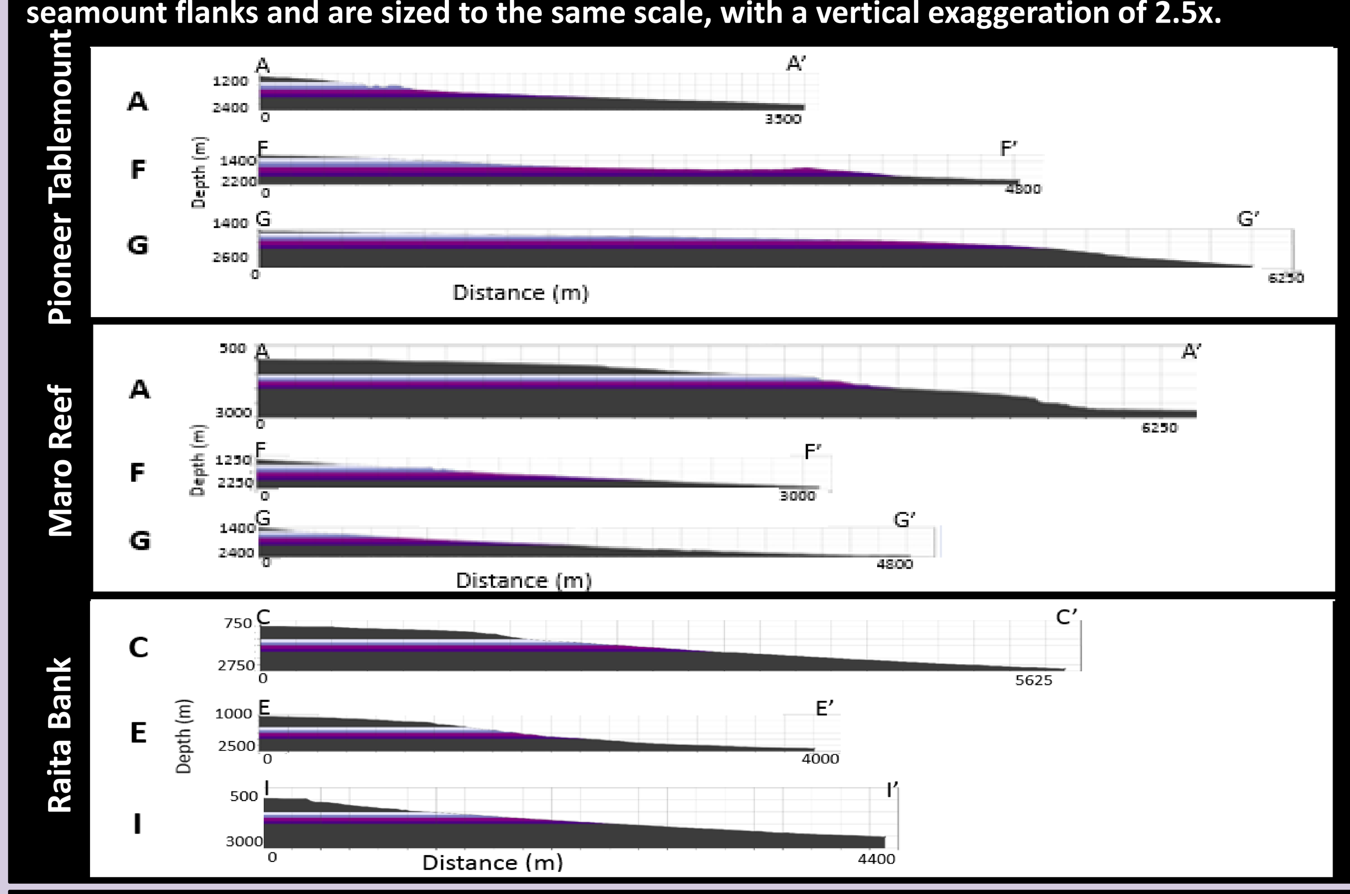


FIGURE 6: Characteristic low slope profiles along transect lines for Pioneer Tablemount (PB), Maro Reef (MI), and Raita Bank (RH). Associated graph is located to the right containing data for all three profiles. All profiles show the seamount flanks and are sized to the same scale, with a vertical exaggeration of 2.5x.

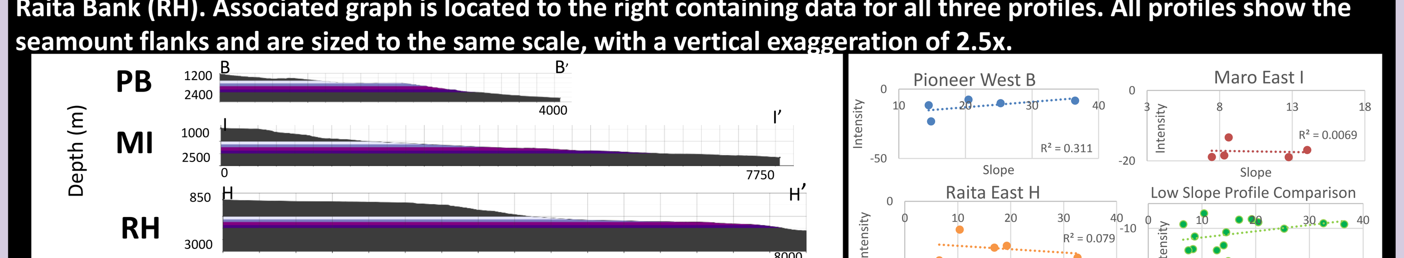


TABLE 1: Depth, slope and intensity values along profile transects A-I for each of the three study sites shown in Figure 3.

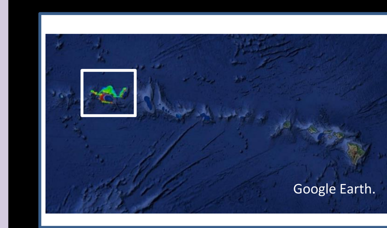
Contour (m)	Depth (m)	Slope	Intensity
Pioneer West A			
1500.0	1500.0	23.1	-6.9
1625.0	1646.2	56.5	-11.3
1750.0	1748.5	20.1	-2.7
1875.0	1876.0	8.7	-3.9
2000.0	2001.1	10.7	-8.7
Pioneer West B			
1500.0	1503.8	20.5	-7.5
1625.0	1611.1	25.3	-10.2
1750.0	1766.5	36.5	-8.4
1875.0	1879.4	14.5	-11.6
2000.0	2003.4	14.9	-23.3
Pioneer West C			
1500.0	1489.7	27.2	-7.7
1625.0	1633.5	31.0	-10.9
1750.0	1754.1	41.4	-15.7
1875.0	1872.3	34.6	-15.6
2000.0	1996.0	33.1	-13.8
Pioneer Central D			
1500.0	1501.0	36.1	-12.4
1625.0	1623.0	10.8	-10.5
1750.0	1750.8	16.3	-20.0
1875.0	1870.6	12.6	-22.7
2000.0	1997.7	23.1	-23.8
Pioneer Central E			
1500.0	1491.4	24.1	-5.3
1625.0	1619.0	38.6	-4.2
1750.0	1750.8	27.4	-9.6
1875.0	1875.1	9.2	-22.8
2000.0	2007.8	22.6	-12.2
Pioneer Central F			
1500.0	1498.4	7.0	-7.9
1625.0	1629.0	24.6	-11.4
1750.0	1749.3	13.2	-10.0
1875.0	1873.5	22.2	-4.7
2000.0	2001.3	15.9	-9.3
Pioneer East G			
1500.0	1500.3	3.4	-8.2
1625.0	1626.1	3.2	-9.1
1750.0	1749.0	10.4	-7.6
1875.0	1877.9	12.4	-9.0
2000.0	2002.6	35.5	-2.6
Pioneer East H			
1500.0	1505.6	6.7	-8.0
1625.0	1621.5	6.7	-10.5
1750.0	1750.2	5.3	-11.7
1875.0	1877.7	24.3	-4.5
2000.0	1995.7	27.9	-1.8
Pioneer East I			
1500.0	1500.1	6.3	-9.3
1625.0	1625.7	5.2	-11.3
1750.0	1748.9	4.5	-10.0
1875.0	1862.4	35.5	-11.1
2000.0	2024.0	36.2	-11.4

Contour (m)	Depth (m)	Slope	Intensity
Maro West A			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Maro West B			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Maro West C			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Maro Central D			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Maro Central E			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Maro Central F			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Maro East G			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	2001.9	16.5	-6.1
Maro East H			
1500.0	1501.9	44.9	-15.2
1625.0	1627.5	18.5	-13.8
1750.0	1747.3	25.8	-15.1
1875.0	1874.4	12.1	-14.4
2000.0	1999.5	11.1	-15.2
Maro East I			
1500.0	1497.3	12.7	-18.9
1625.0	1623.3	8.6	-13.3
1750.0	1747.3	8.3	-18.4
1875.0	1874.4	7.5	-18.9
2000.0	2002.1	14.0	-16.9

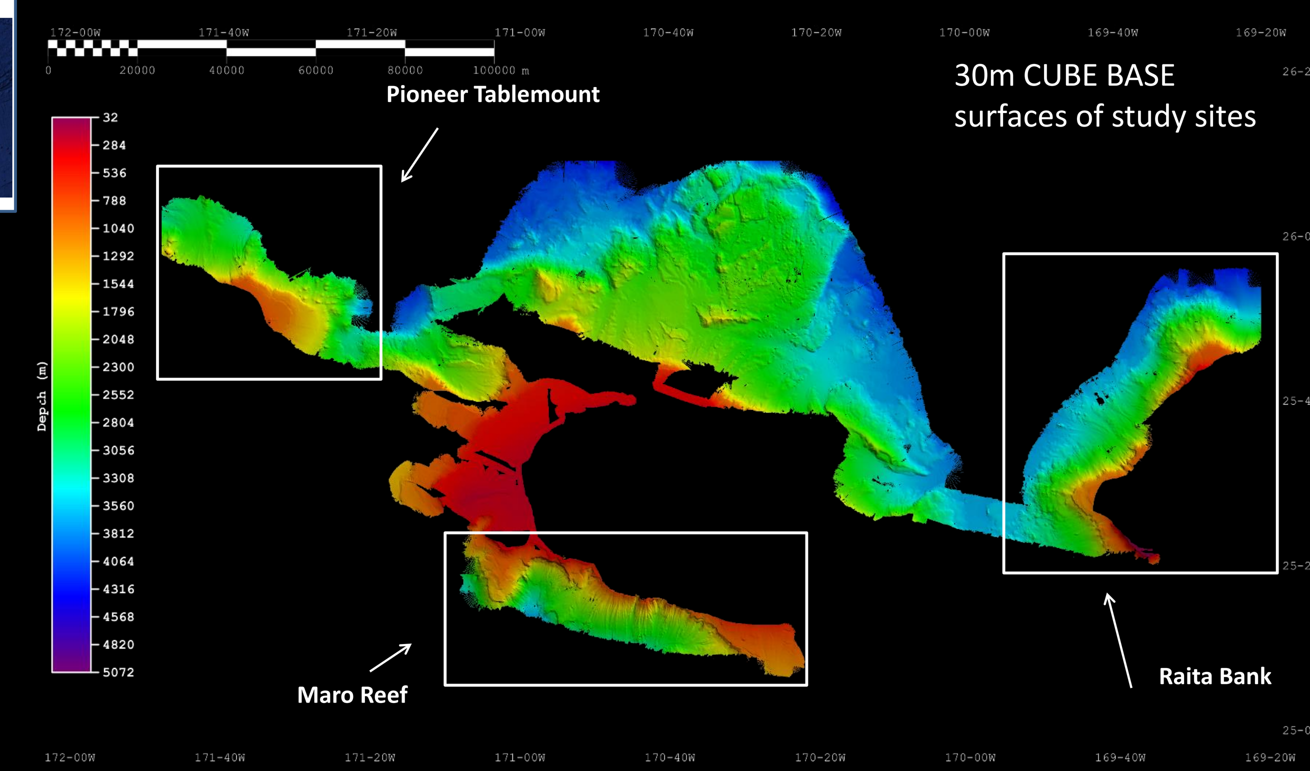
Contour (m)	Depth (m)	Slope	Intensity
Raita West A			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Raita West B			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Raita West C			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Raita Central D			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Raita Central E			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Raita Central F			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	[illegible]	[illegible]	[illegible]
Raita East G			
1500.0	[illegible]	[illegible]	[illegible]
1625.0	[illegible]	[illegible]	[illegible]
1750.0	[illegible]	[illegible]	[illegible]
1875.0	[illegible]	[illegible]	[illegible]
2000.0	1996.3	38.3	-1.4
Raita East H			
1500.0	1499.3	19.2	-6.3
1625.0	1624.8	10.4	-4.0
1750.0	1749.4	6.5	-8.4
1875.0	1878.5	16.9	-6.5
2000.0	1996.1	32.6	-8.0
Raita East I			
1500.0	1498.0	17.5	-7.0
1625.0	1626.6	28.3	-9.0
1750.0	1744.5	19.7	-5.4
1875.0	1878.2	20.1	-3.9
2000.0	1998.6	18.4	-6.0

FIGURE 1: Location of Study Sites

North Hampton Seamounts for the Papahānaumokuākea National Monument



The North Hampton Seamounts are located in the Papahanaumokuakea National Monument located off the North Western Hawaiian Islands. The Study areas include 3 seamounts : Pioneer Table-mount, Maro Reef and the western portion of Raita Bank.



Background

The Papahānaumokuākea National Monument (PMNM) is located in the Northwestern Hawaiian Islands (NWHI), ~1,120 km NW of Honolulu, HI. These islands make up an unhabituated chain of seamounts, basalt pinnacles, atolls, shoals, and banks. Before the 2016 expansion by the Obama Administration, PMNM was created to protect 140,000 mi^2 of NWHI, and the full extent of its biodiversity is still widely unknown. The NWHI corals are relatively isolated, and likely can be studied as a species conservation hotspot, especially when compared to worldwide coral reefs that have suffered a significant loss of biodiversity (Friedlander et al., 2005). Corals are valuable to the study of climate change as they are very slow growing (hundred to thousands of years) and their growth and age can be studied using radioisotope techniques (Etnoyer 2015). Assuming biodiversity is at risk, being able to monitor their health is crucial to assess if damage is occurring.

Between 1998 and 2004 data were collected regarding locations of deep-sea corals throughout the Pacific Ocean. Prior to the establishment of the PMNM, deep corals were found on Pioneer Tablemount – a flat-topped seamount – within a 1500 to 2000 m depth range (Baco and Cairns 2012). The process of sampling these areas is very expensive, time consuming and even time constrained. Having the ability to identify correlating variables to determine where these deep-sea corals are located would be advantageous.

Results

- Backscatter intensity ranged from -23.8 to -1.8 dB (Table 1), and Slope ranged from 3.2 to 56.6 degrees (Table 1).
- All R-squared values for comparison of slope and intensity are between 0.002 and 0.08, and therefore show no correlation (Fig 4).
- Characteristic profiles also show little to no similarity with respect to slope (Fig 5 and Table 1).
- Slope and intensity for low slope profiles have R-squared value of 0.15, showing a weak correlation (Fig 6).

FIGURE 4: Graphs comparing Slope and Intensity within study areas.

Discussion & Conclusion

Deep–sea corals were discovered inhabiting depths ranging 1500 to 2000 m within the area of Pioneer Tablemount (Baco and Cairns, 2012). In this study, the association of slope and backscatter intensities within the deep coral habitat range were compared, and no correlation was found within these depth ranges, whereas low slope profiles (Fig. 6) exhibited a weak correlation. Pioneer Tablemount specifically had a stronger slope-to-intensity correlation for its low slope profile. Knowing that corals have been observed there, our study shows that corals do not necessarily rely on the combination of high degree of slope and hard substrate for attachment. Corals may be more partial to areas that exhibit lower backscatter returns, possibly indicating softer or less consolidated substrate, or they may be more partial to areas with a specific slope range for optimal growth potential.

More information is needed regarding habitat characteristics where coral are found – specifically slope, depth and substrate type – so that this type of multibeam sonar research can improve our ability to identify the preferred habitat characteristics without physically sampling multiple sites. Intensive surveys at a single location are expensive and cannot be repeated numerous times. Finding a reasonable approach to determine what is needed to create predictive models, and collecting the appropriate data are needed to propose a physical sampling of the deep-sea coral area in question. Taking profiles of areas having similar characteristics could be used to analyze intensity and compare areas to potentially limit the number of times a survey must be conducted. Loss of deep sea-corals is the biggest threat to biodiversity in these areas. Providing reliable methods that estimate coral placement or health across an area is essential for keeping these areas protected (Plaisance, 2011).

References Cited

Baco, A.R. and Cairns, S.D., 2012, Comparing Molecular Variation to Morphological Species Designations in the Deep-Sea Coral *Narella* Reveals New Insights into Seamount Coral Ranges, PLoS one, v.7, p.9

Etnoyer, P.J. et al., 2015, "Exploration and Mapping of the Deep Mesoamerican Reef" Oceanography (Washington D.C.) 28(1):34-35

Friedlander, Alan, et al. 2005,"The state of coral reef ecosystems of the Northwestern Hawaiian Islands." *The state of coral reef ecosystems of the United States and Pacific Freely Associated States* 73 :263-306

Plaisance L. et al., 2011, The Diversity of Coral Reefs: What Are We Missing?, PLoS One, v.6, p.10

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