| **Data Documentation** | |
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| **Data Collection Title** | **NCCOS Assessment: Benthic Habitat Maps of Saipan Lagoon, Commonwealth of the Northern Mariana Islands** |
| **Dataset Title** | **Environmental predictor datasets for the Saipan Lagoon, CNMI** |
| **Principal Investigators** | Matthew Kendall, Bryan Costa<br>US DOC; NOAA; NOS; National Centers for Coastal Ocean Science (NCCOS) |
| **Point of Contact** | Matthew Kendall |
| **Collaborators** | Steve McKagan – US DOC; National Oceanic and Atmospheric Administration (NOAA); National Marine Fisheries Service (NMFS); Pacific Islands Regional Office (PIRO), Habitat Conservation Division<br>Lyza Johnston – Commonwealth of the Northern Mariana Islands (CNMI), Bureau of Environmental and Coastal Quality (BECQ) |
| **Authors** | Matthew Kendall, Bryan Costa, Steve McKagan and Lyza Johnston |
| **Abstract** | Twenty-eight environmental predictors were used to create the models and spatial predictions for individual substrate and cover types in Saipan Lagoon, CNMI. There were three broad categories of predictors including: 1) geographic variables based on position in the lagoon, 2) topographic surfaces based on depth and derivatives of depth, and 3) spectral bands from a satellite image. This data package includes the following geospatial datasets (below). For complete descriptions of these datasets and the methods used to generate them, please see Kendall *et al*. (2017).<br><br>**Geographic Predictors.** Four geographic predictors were used to account for spatial variation in benthic habitats that was not explained by the spectral predictors. These included latitude (y), longitude (x), distance to shore, and distance to the reef crest. These surfaces were created using ArcGIS 10.4's Euclidean Distance tool and Marine Geospatial Ecology Tools 0.8a64. The shoreline and reef crest locations were extracted from NOAA's benthic habitat map created in 2005 using a March 2001 IKONOS satellite mosaic.<br>1. Geographic Predictors:<br>a. Reef Crest<br>b. Shoreline<br>c. Distance to Reef Crest<br>d. Distance to Shore<br>e. X Coordinate (Longitude)<br>f. Y Coordinate (Latitude)<br><br>**Topographic Predictors.** Seafloor depth and topography are also known to be useful predictors of specific habitat types such as sand, pavement, and aggregate reef. A satellite-derived (SD) depth surface was created from the World View 2 (WV2) satellite image using 243 *in situ* depth measurements. These depths were corrected for changes in tides, and standardized to the Mean Lower Low Water (MLLW) tidal datum. Coordinates from the 243 sites were used to extract corresponding values from the four geographic and 15 spectral predictors. Boosted Regression Trees models (BRT) were built using this intersected data to predict MLLW depths for the entire Lagoon. Precision (*i.e.*, coefficient of variation or CV) associated with predicted depths was also calculated. The accuracy of the SD depth surface was evaluated using an independent set of 273 in situ depth measurements. Topographic surfaces describing the complexity of the seafloor were derived from the SD depth surface using ArcGIS 10.4's DEM surface tools.<br>2. Seafloor Topography Predictors:<br>a. Curvature (Planform)<br>b. Curvature (Profile)<br>c. Curvature (Total)<br>d. Satellite-Derived (SD) Depth<br>e. Satellite-Derived (SD) Depth (Standard Deviation)<br>f. Satellite-Derived (SD) Depth (Coefficient of Variation)<br>g. Slope<br>h. Slope Rate of Change<br>i. Rugosity |

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| | **Spectral Predictors.** A World View 2 (WV2) satellite image was acquired of Saipan Lagoon on February 5, 2016 at 10:44:34 am local time. Twenty-four of the twenty-eight environmental predictors were derived from this satellite image. Before these predictors were generated, the satellite image was corrected for geometric distortions caused by Saipan's mountainous topography using in ENVI 5.2's Orthorectify WorldView with Ground Control; changes in atmospheric conditions using ENVI 5.2's THOR tool; and changes in water column conditions using the Lyzenga method in ArcGIS 10.4. This resulted in 15 pairs of atmospherically corrected, depth invariant spectral bands.<br>3. Spectral Predictors:<br>j. Depth Invariant Band 1 (Blue-Coastal Blue)<br>k. Depth Invariant Band 2 (Blue-Red)<br>l. Depth Invariant Band 3 (Blue-Red Edge)<br>m. Depth Invariant Band 4 (Blue-Yellow)<br>n. Depth Invariant Band 5 (Coastal Blue-Red Edge)<br>o. Depth Invariant Band 6 (Coastal Blue-Yellow)<br>p. Depth Invariant Band 7 (Green-Blue)<br>q. Depth Invariant Band 8 (Green-Coastal Blue)<br>r. Depth Invariant Band 9 (Green-Red)<br>s. Depth Invariant Band 10 (Green-Red Edge)<br>t. Depth Invariant Band 11 (Green-Yellow)<br>u. Depth Invariant Band 12 (Red-Coastal Blue)<br>v. Depth Invariant Band 13 (Red-Red Edge)<br>w. Depth Invariant Band 14 (Red-Yellow)<br>x. Depth Invariant Band 15 (Yellow-Red Edge) |
| **Purpose** | CNMI's Bureau of Environmental and Coastal Quality (BECQ) and NOAA's Pacific Islands Regional Office (PIRO) partnered with NOAA's National Centers for Coastal Ocean Science (NCCOS) to develop updated habitat maps and assess habitat changes in Saipan Lagoon, CNMI. NCCOS developed these spatially resolved maps using environmental predictors, underwater videos/photos and mathematical modeling techniques. The new maps were designed to inform the Saipan Lagoon Use Management Plan (SLUMP), which is being updated in response to changes in lagoon habitats, user activities, and increases in tourism. Understanding the present spatial distribution of benthic habitats is an important part of the Territorial Government's process to evaluate zoning scenarios, minimize user conflicts, ensure public safety, and prevent environmental degradation inside the lagoon. Products from this assessment may also support coastal and ocean management efforts by other territorial and federal agencies working in Saipan. This work was funded by NOAA Coral Reef Conservation Program (CRCP Project #31100). |
| **Methods** | See Kendall et al. (2017). |
| **Citations** | Kendall, M., B. Costa, S. McKagan, L. Johnston, and D. Okano. 2017. Benthic Habitat Maps of Saipan Lagoon. NOAA Technical Memorandum NOS NCCOS 229. Silver Spring, MD. 79 pp. |
| **Start Date** | 2016-02-05 |
| **End Date** | 2016-02-05 |
| **Northern Boundary** | 15.2742160669 |
| **Southern Boundary** | 15.1209203637 |
| **Western Boundary** | 145.684723941 |
| **Eastern Boundary** | 145.794770192 |
| **Projection** | For all layers, Horizontal Coordinate System: World Geodetic System 1984 (WGS84), Universal Transverse Mercator, Zone 55 North (UTM 55N)<br>For Satellite-Derived (SD) Depth, Vertical Coordinate System: Tidal Datum, Mean Lower Low Water(MLLW) |
| ***Resource Provider*** | *NCCOS Data Manager <nccos.data@noaa.gov>* |
| ***Comment*** | *This data documentation describes numerous geospatial datasets archived together as a NOAA NCEI data collection, and is intended to provide dataset-level metadata for the purposes of discovery, use, and understanding.* |
| ***Use Limitation*** | *Please note: NOAA makes no warranty, expressed or implied, regarding these data, nor does the fact of distribution constitute such a warranty. NOAA cannot assume liability for any damages caused by any errors or omissions in these data.* |

| Datasets: Geographic Predictors | Definition, Format, Compression, Spatial Resolution, Units, Time Period, Instrument & Source |
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| Reef Crest | Reef crest around Saipan Lagoon. Format polygon shapefile; no compression; spatial resolution n/a; units n/a, time period 2001-03; instrument n/a; data source NOAA NCCOS (National Centers for Coastal Ocean Science). 2005. Atlas of the Shallow-Water Benthic Habitats of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands. NOAA Technical Memorandum NOS NCCOS 8. Silver Spring, MD. 126 pp. Online: https://products.coastalscience.noaa.gov/collections/benthic/e99us_pac/ (Accessed 16 February 2017). |
| Shoreline | Saipan shoreline. Format polygon shapefile; no compression; spatial resolution n/a; units n/a, time period 2001-03; instrument n/a; data source NOAA NCCOS (National Centers for Coastal Ocean Science). 2005. Atlas of the Shallow-Water Benthic Habitats of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands. NOAA Technical Memorandum NOS NCCOS 8. Silver Spring, MD. 126 pp. Online: https://products.coastalscience.noaa.gov/collections/benthic/e99us_pac/ (Accessed 16 February 2017). |
| Distance to Reef Crest | Distance of each 2x2 m pixel from the reef crest. Format geotiff; no compression; spatial resolution 2x2 meters; units meters; time period n/a; instrument n/a; data source Kendall et al. 2017. |
| Distance to Shore | Distance of each 2x2 m pixel from the shoreline. Format geotiff; no compression; spatial resolution 2x2 meters; units meters; time period n/a; instrument n/a; data source Kendall et al. 2017. |
| X Coordinate (Longitude) | Longitude (in meters) of each 2x2 m pixel. Format geotiff; no compression; spatial resolution 2x2 meters; units meters; time period n/a; instrument n/a; data source Kendall et al. 2017. |
| Y Coordinate (Latitude) | Latitude (in meters) of each 2x2 m pixel. Format geotiff; no compression; spatial resolution 2x2 meters; units meters; time period n/a; instrument n/a; data source Kendall et al. 2017. |

| Datasets: Seafloor Topography Predictors | Definition |
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| Curvature (Planform) | Seafloor curvature perpendicular to the line of maximum slope. Value indicates whether flow will converge or diverge over a point. Values can be - (concave) or + (convex). Format geotiff; no compression; spatial resolution 2x2 meters; units radians meters; time period n/a; instrument n/a; data source Kendall et al. 2017. |
| Curvature (Profile) | Seafloor curvature along the line of maximum slope. Values indicate whether flow will accelerate of decelerate over the curve. Values can be + (concave), - (convex), or 0 (flat). Format geotiff; no compression; spatial resolution 2x2 meters; units radians meters; time period n/a; instrument n/a; data source Kendall et al. 2017. |
| Curvature (Total) | Seafloor curvature; Values > 0, with 0 indicating surface is flat. Format geotiff; no compression; spatial resolution 2x2 meters; units radians meters; time period n/a; instrument n/a; data source Kendall et al. 2017. |
| Satellite-Derived (SD) Depth | Seafloor depth referenced to Mean Lower Low Water (MLLW). This surface was created using in situ depths, World View 2 (WV2) satellite image and boosted regression trees (BRTs). Format geotiff; no compression; spatial resolution 2x2 meters; units meters; time period 2016-02-05; instrument n/a; data source Kendall et al. 2017. |
| Satellite-Derived (SD) Depth Coefficient of Variation (CV) | Precision or uncertainty associated with SD depths described as the ratio of the standard deviation to the mean. Format geotiff; no compression; spatial resolution 2x2 meters; units n/a; time period 2016-02-05; instrument n/a; data source Kendall et al. 2017. |
| Satellite-Derived (SD) Depth Standard Deviation | Standard deviation of depths within a 3x3 pixel neighborhood. Format geotiff; no compression; spatial resolution 2x2 meters; |

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| | units meters; time period 2016-02-05; instrument n/a; data source Kendall et al. 2017. |
| Slope | Maximum slope within a 3x3 pixel neighborhood. Format geotiff; no compression; spatial resolution 2x2 meters; units degrees; time period 2016-02-05; instrument n/a; data source Kendall et al. 2017. |
| Slope Rate of Change | Rate of slope change within a 3x3 pixel neighborhood. Format geotiff; no compression; spatial resolution 2x2 meters; units degrees; time period 2016-02-05; instrument n/a; data source Kendall et al. 2017. |
| Rugosity | Ratio of seafloor surface area to planar area describing topographic roughness. Values range from 1 (flat) to infinity. Format geotiff; no compression; spatial resolution 2x2 meters; units n/a; time period 2016-02-05; instrument n/a; data source Kendall et al. 2017. |

| **Datasets: Spectral Predictors** | **Definition** |
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| Depth Invariant Band 1 (Blue-Coastal Blue) | Seafloor reflectance. World View 2 (WV2) band pairs corrected for atmospheric and water-column conditions. Format geotiff; no compression; spatial resolution 2x2 meters; units seafloor reflectance; time period 2016-02-05; instrument World View 2 satellite. Active as of March 2016; data source Kendall et al. 2017. |
| Depth Invariant Band 2 (Blue-Red) | |
| Depth Invariant Band 3 (Blue-Red Edge) | |
| Depth Invariant Band 4 (Blue-Yellow) | |
| Depth Invariant Band 5 (Coastal Blue-Red Edge) | |
| Depth Invariant Band 6 (Coastal Blue-Yellow) | |
| Depth Invariant Band 7 (Green-Blue) | |
| Depth Invariant Band 8 (Green-Coastal Blue) | |
| Depth Invariant Band 9 (Green-Red) | |
| Depth Invariant Band 10 (Green-Red Edge) | |
| Depth Invariant Band 11 (Green-Yellow) | |
| Depth Invariant Band 12 (Red-Coastal Blue) | |
| Depth Invariant Band 13 (Red-Red Edge) | |
| Depth Invariant Band 14 (Red-Yellow) | |
| Depth Invariant Band 15 (Yellow-Red Edge) | |