**West Coast Substrate Map Upgrade**

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Introduction

Substrate data, and specifically induration type (i.e., “hardness”), represent a critical habitat input for the spatial modeling of groundfishes and structure-forming marine invertebrates such as deepwater corals. To facilitate these type of modeling efforts, as well as broader scientific and fisheries management needs, a West Coast substrate map was produced in 2005 as part of NMFS’ five-year review of essential fish habitat. This contiguous polygon map spanned the coast from the Canadian to Mexican borders, and, where data were available, offshore to the EEZ. It was interpreted by experienced geologists using a four-category, hierarchical scheme after Greene et al. (1999). Induration was defined as hard (rock pavement, outcrops/reefs, or boulders), soft (silt to cobbles), or mixed (one hard and one soft induration type) substrate; however, only hard and soft induration types were identified in California waters, based on the predominant induration type. In 2011, as part of the subsequent EFH review, an extensive data mining exercise was undertaken to compile any new or missing data sets (“habitat maps”) that depicted induration type. These new files were merged into the 2005 map to produce a 25 m x 25 m raster layer, with the highest resolution data depicted when different coverages overlapped.

There are some limitations to this 2011 substrate map that make it inadequate for the deepwater coral mapping project and necessitated an upgrade. One problem stems from inconsistent data type and accuracy between the regions north and south of Fort Bragg. To the north, the original map was updated periodically since its creation in 2005 and depicts hard, mixed, and soft substrate types (see Goldfinger et al. 2014). By contrast, the region south of Fort Bragg distinguishes only hard and soft substrate types, and was not formally updated since 2005. In addition, although data of various types and resolutions are embedded in the 2011 map, there is no data quality information included. Therefore, each raster cell is inherently assumed to have the same predictive ability. These incongruities create significant limitations and biases to coast-wide modeling efforts.

Methods

*Upgrading Seafloor Induration Data*

The primary goal of this effort was to address the biases inherent to the 2011 map to produce a new substrate map that is more consistent and accurate at depicting seafloor induration. A secondary goal, contingent with the project time frame, was to compile and embed new induration data. This second component was more important for California waters south of Ft. Bragg, which hadn’t been updated since the 2011 effort.

Data sources from the 2005 and 2011 mapping efforts south of Ft. Bragg were located and inspected to determine if a mixed component could be added. Unfortunately, none of the original data sources from the 2005 mapping effort contained this information and these data sets remain restricted to hard and soft designations. Several data sets that were compiled during 2011 did include a mixed induration category and were incorporated to replace the original (hard and soft) coverages. All polygon coverages were converted to (25 m x 25 m) rasters in ArcMap (v 10.4.1) using the maximum combined area method with snapping set to the 2011 map to ensure proper cell alignment. Raster coverages often were present in a variety of resolutions (e.g., 2 m, 5m, and 10 m cell size) and were resampled to a 25 m grid size using a nearest neighbor technique. Input rasters were snapped to the original 2011 map extents during resampling, and then merged using the Mosaic to New Raster tool with higher resolution data taking priority when coverages overlapped.

An exhaustive data mining effort was not possible within the time frame of the project but new induration data were added throughout the expanse of the substrate map. North of Ft. Bragg, this information was derived from Goldfinger et al. (2014). South of Ft. Bragg, 33 new coverages were compiled from the California State University, Monterey Bay Seafloor Mapping Lab, the United States Geologic Survey State Mapping Project, and Moss Landing Marine Laboratories’ Center for Habitat Studies. Most new data coverages, especially south of Ft. Bragg, were located in state waters. All new data sets were processed as previously described and a new map (2017 West Coast Substrate Map) was produced that depicts hard, mixed, and soft substrate. Because mixed substrate was not always identified on input maps, a second map was created by incorporating all mixed types into the “hard” category.

*Creating a Data Quality Layer*

Accounting for differential quality of induration data is a crucial element of the map upgrade and required the creation of an appropriate scheme. This scheme has three fundamental components (or categories): data type, interpretation type, and groundtruthing. Scoring ranged from 0-3 in each category, and differential scoring among categories was based on their perceived relative importance in accurately distinguishing hard, mixed, and soft substrate types. This scheme is as follows:

Data Type:

0.25 Low resolution data (cores, > 100 m gridded or > 1:100,000 scale multibeam bathymetry or sidescan/backscatter, seismic lines, bathymetric countour maps)

1.5 Medium resolution data (> 10-100 m gridded or > 1:10,000-100,000 scale multibeam bathymetery or sidescan/backscatter)

3.0 High resolution data (< 10 m gridded or 1 :< 10,000 scale multibeam bathymetery or sidescan/backscatter)

Interpretation Type:

1.5 Unsupervised classification (e.g., Terrain Ruggedness (VRM))

3.0 Supervised classification (e.g., machine learning or expert interpretation)

Groundtruthing:

0 No groundtruthing

1.5 Limited groundtruthing

3.0 Comprehensive groundtruthing

Categories also were weighted based on perceived relative importance as follows: Data Type = 3, Groundtruthing = 1.5, Interpretation Type = 1.0. Eighteen different data quality scores are possible based on this category, ranging from 1-10 (Table 1).

Associated data quality maps were constructed for the substrate maps by compiling or creating footprint maps to match the original seafloor data sets, then scoring those data sets for data quality. This process was conducted in the same stages as the original mapping effort; 2005 input data were first compiled, then 2011 data, then the data included in the current upgrade. For each subsequent compilation, footprint maps that overlapped were merged to match the orientation of the associated substrate maps (“best” data on top of lesser data). All processing (i.e., resampling, mosaicking, snapping) was conducted as previously described. For the map version that distinguished only soft and hard induration types, the original data quality scores of all mixed induration cells should be reduced by ½ during analysis to reflect added uncertainly in converting them to hard induration cells.

Literature Cited:

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