Not all sand is created equal: A case for updating California's Marine Life Protection Act habitat classification

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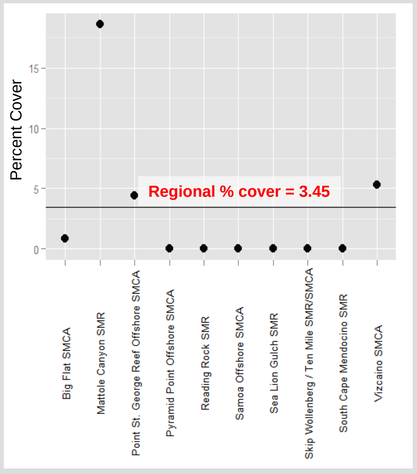
Introduction

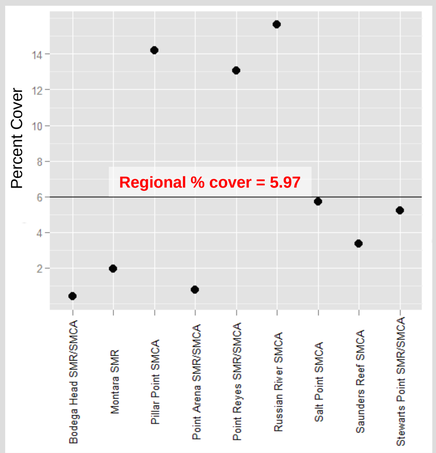
Rippled scour depressions (RSDs) are prominent sediment features found on continental shelves worldwide. They are characterized by coarse grain sediment in comparison to the surrounding sand plateau and long period sand waves inside of the depressions (0.4m-1m depth)(figures 2 and 4). A review of data collected for the California Seafloor Mapping Project (CSMP) showed that Rippled Scour Depressions (RSDs) were found to represent a significant portion (4.3%) of the soft sediment habitat previously defined as homogeneous. ROV investigations in a companion study in the Monterey Bay suggest RSDs may be important nursery grounds for juvenile rockfish (fig. 3), lingcod and other ground fish species of concern targeted by the 1999 California Marine Life Protection Act (MLPA). The MLPA requires the state to establish a network of Marine Protected Areas (MPAs) representative of the regional benthic habitat using two basic physical habitat properties: depth zone (0-30, 30-100, 100-200, > 200) and substrate type (rocky reef, soft-sediment) (MLPA, 2008). To date these ecologically important habitats (RSDs) have not been considered in the design or monitoring of the California MPA network and therefore may not be adequately represented within their boundaries. Here we apply an ArcGIS landscape analysis tool set, first developed for use in Monterey Bay to compare the percent coverage of RSDs throughout California state MPAs to their MLPA regions using multibeam sonar bathymetry and backscatter data from the CSMP. The goal of this study is to determine whether rippled scour depressions are being properly represented in California's MPA network.

North Coast Region



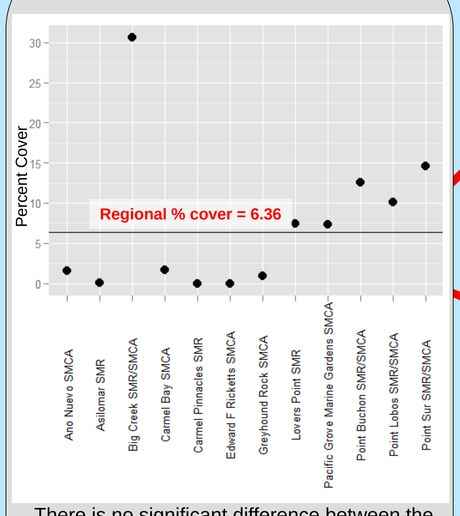
There is no significant difference between the RSD percent cover of the north central region (μ =.0345) and the mean RSD percent cover of the MPAs within the region. (p=.782)

North Central Region



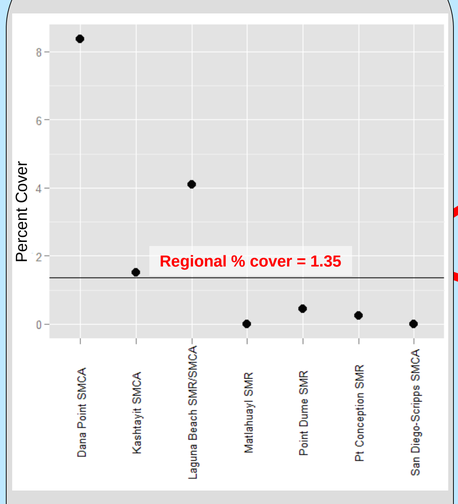
There is no significant difference between the RSD percent cover of the north central region (μ =.0597) and the mean RSD percent cover of the MPAs within the region. (p=.729)

Central Coast Region

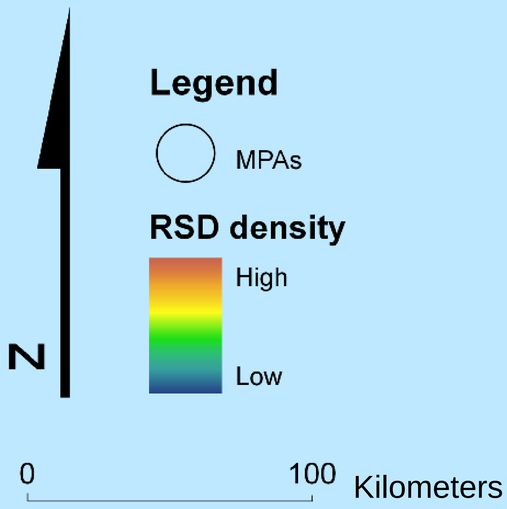


There is no significant difference between the RSD percent cover of the central region (μ =.064) and the mean RSD percent cover of the MPAs within the region. (p=.748)

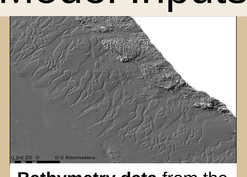
South Coast Region



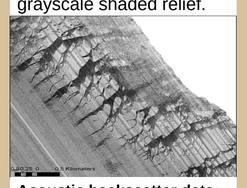
There is no significant difference between the RSD percent cover of the south region (μ =.0135) and the mean RSD percent cover of the MPAs within the region. (p=.55)



Model Inputs

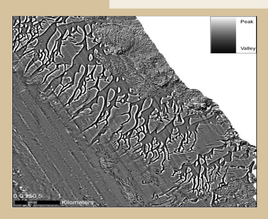


Bathymetry data from the California Seafloor Mapping Project: shown in grayscale shaded relief.

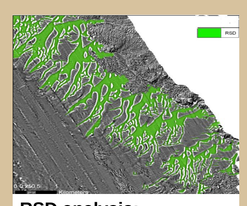


Acoustic backscatter data: darker areas represent coarser sediment composition.

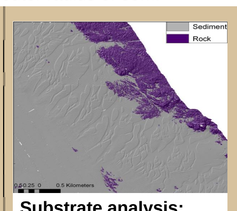
Model Intermediates



Topographic Position Index (TPI):TPI determines height relative to its neighbors and identifies RSD edges. The TPI analysis employed was done using the algorithm of Weiss (2001),which uses and annulus (donut) shaped neighborhood of inner radius 30m and outer radius of 35m.

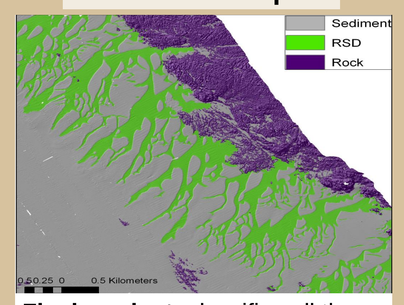


RSD analysis: differentiates RSDs from all other substrate.



Substrate analysis: differentiates sediment from rocky substrate.

Model Output



Final product: classifies all three bottom habitat types. Sediment, RSD and Rock

Figure 1: Workflow model of RSD auto-classifciation tool.

Methods

For this study we developed and applied Geographic Information System (GIS) auto-classification modeling tools (figure 1) to California Seafloor Mapping Project data to distinguish rippled scour depressions from other sediment and to comprehensively quantify the distribution and abundance of RSDs across the California MPA network. A ROV was used to ground truth the RSDs in the Monterey Bay, as well as for the ecological companion study. The density map of RSDs across the coast was created in ArcGIS their centroid and area to illustrate their distribution and hotspots in relationship to MPA location. The average RSD percent cover inside MPAs was compared to their MLPA region using single sample t tests.

What are RSDs?

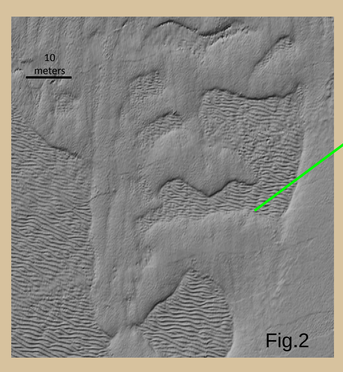


Figure 2. Shaded relief image of the ripples inside RSD. Figure 3. ROV video data from inside RSD shows juvenile rockfish in the ripples.

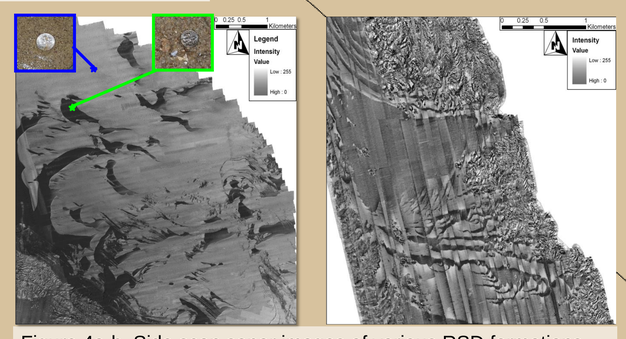


Figure 4a-b. Side scan sonar images of various RSD formations found along the coastline. Darker areas represent the coarser areas of sediment.

Discussion

Results from the CSMP data analyzed show RSDs are found throughout the California continental shelf within state waters, but with higher percent cover in the northern and central regions of the state compared to the south. Mean RSD percent cover in MPAs within a region was found to not be significantly different in any of the four analyzed MLPA regions, which suggests that RSDs are adequately represented within the group of MPAs in each region. However in many areas the aerial extent of RSD habitat is equal to or exceeds that of rocky reef habitat. The ecological significance of this fact is amplified by the results from the initial ROV surveys in Monterey Bay which found dense aggregations of endangered young of the year Canary rockfish inside of RSDs, as well as other important biological differences compared to the surrounding soft-sediment habitats. RSDs present a relatively undiscovered habitat that supports a unique and diverse benthic community. RSDs should be considered by management to ensure all representative habitats are being protected and for future progress in the California MPA network.