

UNIVERSITY OF CALIFORNIA
Santa Barbara

**EVALUATING THE PROTECTION OF DIVERSE AND REPRESENTATIVE
COASTAL AND MARINE HABITATS WITHIN CALIFORNIA'S MARINE
PROTECTED AREA (MPA) NETWORK**

Technical Documentation

A Capstone Project submitted in partial satisfaction of the requirements
for the degree of
Master of Environmental Data Science
For the
Bren School of Environmental Science and Management

By

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Abstract

The Marine Life Protection Act of 1999 endeavors to protect the “natural diversity and abundance of marine life” along the California coastline and its nearshore environments, promoting the protection of marine habitats, ecosystems, and natural heritage.¹ In pursuit of informing these goals, substantial advances in Marine Protected Area (MPA) habitat measuring have occurred since the initial MPA planning process, particularly in remote sensing and habitat mapping. Under the guidance of researchers involved in the recent decadal evaluation of California’s MPA network, our team evaluated whether the network protects a diverse range of habitats in proportion to their natural abundance within state waters. Our team integrated existing spatial habitat datasets to generate map layers representing key habitat components across California state waters. These layers were used to analyze the habitat component makeup inside MPAs compared to composition and variation outside of the network. We identified how different habitats, defined by the presence of unique foundation species, were protected under different MPA designations and standardized the method of calculating the composition of habitat within each MPA. Our findings culminated in a written report summarizing this process, which includes effective visualization of key insights through tables, figures, and maps, as well as an interactive dashboard. It is our great hope that this report be used to inform the continued protection and effective management of California MPAs, and be further utilized by researchers engaged with habitat composition analysis for a wide range of applications.

¹ (1999) Marine Life Protection Act, California Department of Fish and Wildlife

Executive Summary

Background

Coastal marine environments provide vital and diverse ecosystem services to coastal communities, but are increasingly threatened by both localized and global anthropogenic activity.^{2 3} With an extremely expansive coastline roughly 1,760 kilometers long⁴, the state of California supports a wide array of coastal and marine ecosystems that contribute significantly to environmental protection and economic activity. For example, California commercial fisheries generate an estimated \$150 million annually for the state economy⁵, while tourism to coastal and marine areas contributes at least \$93 billion each year⁶.

These crucial marine environments are established and maintained by foundation species—organisms whose physical or chemical characteristics construct hospitable environments that act as a shelter from disturbance and predation⁷. Examples of foundation species that support unique habitats are giant kelp, eelgrass, deep sea coral, mussels, etc. As key biotic components of coastal and marine habitats, the distribution of foundation species is closely tied to the distribution and function of their associated habitats⁸.

In 2022, the Marine Protected Area Network underwent its first 10 Year Decadal Review, which “serves as an update on the four pillars of the MPA Management Program: Outreach and Education, Research and Monitoring, Enforcement and Compliance, Policy and Permitting.”⁹ This review included evaluations of progress towards meeting these goals.

In that same year, the Pacific Marine & Estuarine Fish Habitat Partnership (PMEP) compiled a massive dataset on foundation species coverage across the western coast of the United States. This effort integrated 20 separate biotic datasets and standardized their habitat classifications to align with the Coastal and Marine Ecological Classification Standard (CMECS).¹⁰ Similarly, in 2023, the National Oceanic and Atmospheric Administration (NOAA)’s West Coast Deep Sea Coral Initiative

² (2022) Wedding et al.

³ (2008) Halpern et al.

⁴ (2019) Griggs & Patsch

⁵ (2013) Sea Grant California

⁶ (2018) Houston J.R.

⁷ (2011) Angelini et al.

⁸ (2019) Ellison et al.

⁹ (2022). California’s Marine Protected Network Decadal Network Review

¹⁰ (2022) Bizzarro et al.

released a dataset containing biotic observations from deeper waters not typically covered by PMEP data, along with updated bathymetric information.

The Marine Life Protection Act (MLPA) endeavors to protect marine natural heritage and biodiversity through regulation of human interaction with marine ecosystems. The statewide system was agreed upon as a way to “increase coherence and effectiveness in protecting the state's marine life and habitats” and to “improve recreational, educational and study opportunities provided by marine ecosystems subject to minimal human disturbance” throughout the state.

Motivation

Within the six core goals for the MPA system outlined in the Marine Life Protection Act, the inclusion of “representative and unique marine life habitat” is mentioned as one of the key tenets, or pillars underpinning the management framework. We interpreted “representative habitat” to mean habitat types protected in proportion to their natural abundance, a concept that guides MPA placement, management, and monitoring within California’s MPA network to this day. Thus, our clients, including researchers involved in the recent decadal evaluation of California’s MPA network¹¹, partners at the California Department of Fish & Wildlife (CDFW), and the California Ocean Protection Council, tasked us with assessing whether the network effectively captured “representative habitat”. To do so, we integrated these newly synthesized data sets on a wide variety of habitat components, to provide a more accurate representation of habitat makeup within California waters. These datasets were not available at the time of the decadal review, but help create a more comprehensive view of the habitats that exist along the coast of California. Our clients expressed that developing a framework for California habitat composition and distribution analysis would not only be useful for informing MPA management, but for garnering a greater understanding of the California coastal and marine environments.

Problem statement/Knowledge gap

With the opportunity to interpret updated datasets in support of habitat management under MPAs, we assessed how habitat protection varies across California waters by analyzing the distribution of habitat components within MPAs and across MLPA working group defined study regions (also known as bioregions). We evaluated whether habitat types were protected in proportion to their availability in the broader marine environment. In addition, we examined the role that estuaries have in these comparisons.

¹¹ (2022). California’s Marine Protected Network Decadal Network Review

Our final products and deliverables include (1) a scientific report summarizing habitat distribution within the MPA network, with comparisons across study bioregions and the broader coastal environment, and (2) an interactive map allowing users to visually explore the datasets utilized in this analysis.

Key findings

Our team used three primary datasets from the Pacific Marine and Estuarine Partnership (PMEP) to calculate habitat composition: biotic (living organisms), substrate (non-living seafloor), and depth zone. These layers were spatially intersected to identify overlapping habitat combinations. We then performed statistical analyses to calculate the percent area covered by each habitat type, which we applied to our area of interest. Our main analyses focused on: (1) comparing bioregions—areas with similar ecological systems—to the broader environment, and (2) comparing habitat composition inside Marine Protected Areas (MPAs) to areas outside MPAs along the California coast to assess whether habitats are being adequately represented and protected. Both absolute abundance and relative abundance were calculated, in order to compare the available data to itself, as well as to assess what proportion of the environment was composed of certain components. Additional data sets, such as PMEP estuary data and NOAA coral data were used to supplement these analyses.

A few key findings that have come from this report are:

- The California MPA network captures a wide variety of habitat types in close proportion to their abundance.
- California aquatic vegetation is well represented within the MPA network, but faunal beds are less so.
- Estuaries are underrepresented in the California MPA system.

Approach

To accomplish our objectives and produce deliverables, our team followed the four phase process illustrated below:

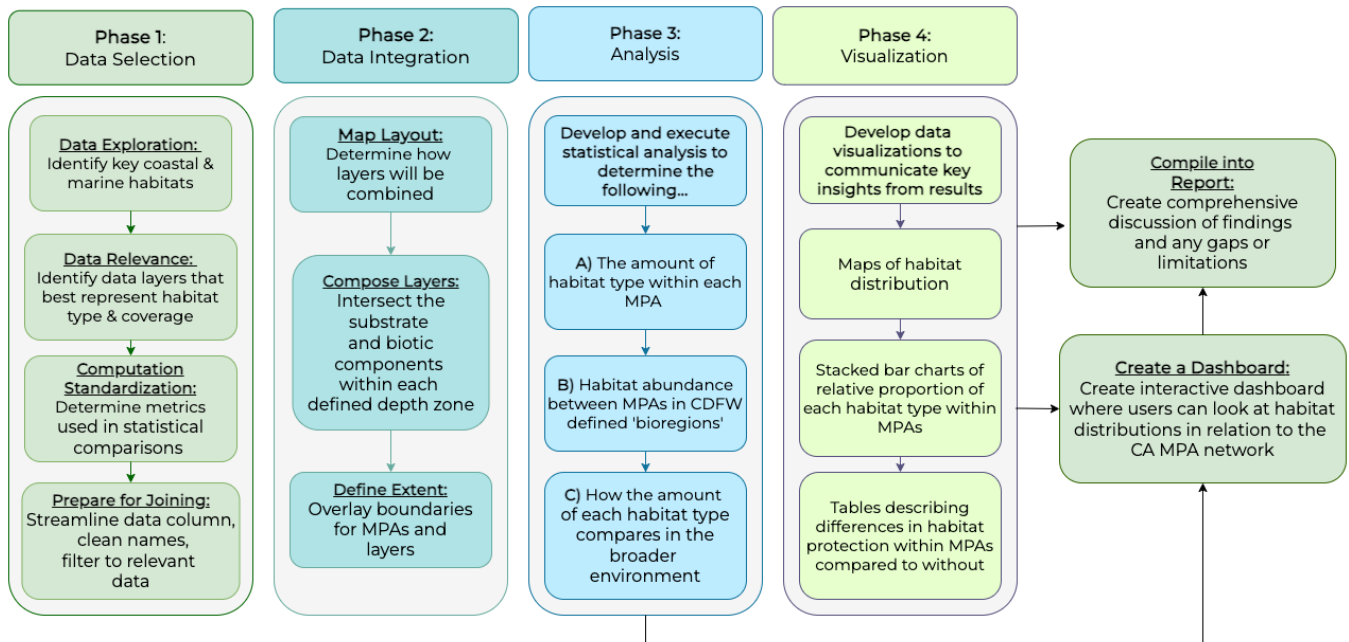


Figure 1. Workflow diagram outlining the four main stages of the project workflow, including data selection, integration, analysis, visualization, and development of final deliverables.

To assess how well California's Marine Protected Area (MPA) network represents diverse marine habitats, we followed a four-phase workflow. First, we identified and selected key habitat datasets aligned with the Coastal and Marine Ecological Classification Standard (CMECS), which included biotic, substrate, bathymetry, and estuary layers from PMEP. Next, we integrated and cleaned these data to create composite spatial layers based on biotic cover, substrate, and depth zones which were overlaid with MPA and bioregional boundaries. Estuary data was also added to supplement the biotic components. We then performed spatial and statistical analyses to compare habitat composition, or where data layers overlapped, across bioregions and to the broader environment. Finally, we created a series of data visualizations and an interactive web dashboard with an interactive map to summarize and communicate our results.

Methods

Data and Data Lifecycle:

The key datasets that formed the foundation for the habitat composition analysis were sourced from the Pacific Marine & Estuarine Fish Habitat Partnership (PMEP). PMEP provided three primary data layers for our habitat composition analysis: the

biotic layer, representing the living components of the MPA such as vegetation and marine life, the substrate layer, which captures the non-living elements such as sediment and rock that form the physical foundation of the habitat. Bathymetric data was integrated into the substrate and biota datasets, to help provide ecological context for the locations of biotic and substrate components. Habitat definitions are aligned with the Coastal and Marine Ecological Classification Standards (CMECS), allowing for integration with other data sources following this standard. The final data layer consists of MPA boundary data, which is used to intersect with the habitat layers to define the areas of interest for our analysis.

PMEP adheres to CMECS standards when defining habitat categories. We adhered to these PMEP and CMECS classification conventions for both biotic and substrate categories to maintain consistency with established regional standards and ensure comparability with other PMEP-supported analyses. We kept our analysis to the “category” level for both biota and substrates, with substrate and biota “class” levels nested within the different categories. Detailed tables outlining these CMECS classification schemes and their justifications are provided in the metadata file accompanying the official report. Substrate categories are defined as such: Unconsolidated Mineral Substrate, Rock Substrate, Fine Unconsolidated Substrate, Course Unconsolidated Substrate, Anthropogenic Substrate, Biogenic Substrate. Biota categories are defined as such: Canopy-Forming Algal Bed, Aquatic Vegetation Bed, Benthic Macroalgae, Faunal Bed, Seagrass Bed, Benthic/Attached Biota, Floating/Suspended Plants and Macroalgae.

Bathymetry analysis was conducted using the depth zones data integrated into the PMEP substrate and biota data. PMEP stratifies depth into 8 different “zones”. These zones help to illuminate the depths where habitat components are likely to occur. Only the depth zones within California State Waters were considered for this analysis, due to client’s objectives, which are state-focused. The depth zones are defined as such: Zone 2: Core Zone (Shoreline to -30m), State Waters, Zone 6: Deep Shelf or Sound (-100m to -200m), State Waters, Zone 4: Seaward Zone (-30m to -100m), State Waters, Zone 0: Landward Zone, Zone 8: Outside PMEP Scope (>-200m) or International Waters. For Zone 8, we are considering the parts of the zone that are within State Waters (not International), but are greater than 200 meters deep.

Supplemental datasets provide further context for the habitat components, with PMEP offering an eelgrass dataset and NOAA for deep sea coral data. Each dataset spans the full extent of California state waters. The final dataset used was PMEP estuary data, providing biotic habitat information for estuaries along the California coast. This will be used to supplement the main MPA habitat component analysis. One challenge the team encountered across all three PMEP datasets—biotic, substrate, and depth zones—was the high proportion of areas labeled as

“Unclassified.” In the biotic dataset, “Unclassified” encompassed both locations with no observations and those with observations that lacked species identification. Similarly, the substrate and depth zone layers included regions that were either unobserved or lacked sufficient classification data. Following our client’s recommendation, we excluded all “Unclassified” areas from our analyses to focus on habitat types with reliable classification. Each instance where these exclusions affected the analysis is clearly documented in the corresponding Quarto documents.

There are two primary forms of metadata created for this project. The first is a comprehensive README.md file that will be stored within our primary GitHub Repository housed in our GitHub Organization. The second form is the generated report itself. The report’s target audience is the MPA working group and includes extensive detail about our process and methods.

 Table 1: Raw Data Summary 		
Data	Data type	Source
California MPAs shapefiles	.cpg, .dbf, .prg, .shp, .shx, .xml	CA Department of Fish and Wildlife
Substrate (rock vs. sediment)	.freelist, .gdbtable, .gdbtblx, .horizon, .atx, .gbindexes, .spx	PMEP Nearshore Substrate Component
Nearshore biotic habitat	.freelist, .gdbtable, .gdbtblx, .horizon, .atx, .gbindexes, .spx	PMEP Nearshore Biotic Component
Deep Sea Biota	.tif, .csv	NOAA West Coast Deep Sea Coral Initiative , obtained from client via Google Drive
Biotic cover within estuaries	.freelist, .gdbtable, .gdbtblx, .horizon, .atx, .gbindexes, .spx	PMEP Estuarine Biotic Component
Eelgrass extent	.gdb	PMEP Eelgrass Habitat

Table 1. Summary of all datasets used in this project, including the dataset name, type and data source.

Analysis:

Formation of RDS files

To improve data processing efficiency, the biotic and substrate datasets were first filtered to California State Waters, and converted to an RDS file format, significantly reducing load times. These files were reprojected to UTM Zone 10N (EPSG: 32610) to align with the California coastline, and a new column was created to calculate the area (in hectares) for each habitat observation. These files represent biotic and substrate habitat information that exist both inside and outside MPAs, or all data along the California coastline.

The Marine Protected Area (MPA) boundary dataset was similarly transformed to match the same coordinate reference system. Geometries were validated, and the existing hectare column was renamed to distinctly represent MPA area.

To create bioregion specific RDS files, the MPA dataset was first filtered to PMEP defined regions of Pacific Northwest, Central California, and Southern California Bight. These areas were then spatially intersected with the biotic and substrate RDS files, then filtered again to the four bio-regions (North Coast Study Region, North Central Coast Region, Central Coast Study Region, and South Coast Study Region), then. This process resulted in eight region-specific RDS files containing only the overlapping habitat data—biotic or substrate—within each bioregions MPA boundaries.

A similar workflow was used to generate RDS files containing biotic and substrate habitat information inside and outside of MPAs. To produce the datasets for areas within all MPAs, the biotic and substrate data from the filtered PMEP-defined regions were combined (bound together) across the three regions. This process resulted in two comprehensive RDS files—one for biotic data and one for substrate data—representing only the habitat features located within MPA boundaries.

Bioregion Analysis

A similar workflow was used to calculate habitat composition across all bio-regions and for each of the three primary datasets: biotic, substrate, and bathymetry (depth zones).

After loading the data, geometry columns were removed to reduce processing time. The percentage calculation proceeded in three main steps:

1. The total area of all biotic, substrate, or depth zone features within each region's MPAs was calculated.

- a. For the biotic and substrate datasets, the features selected for analysis were the respective biotic and substrate categories. These categories are standardized summaries based on the CMECS Origin, Class, or Subclass units. This feature was chosen because it was consistently available across both datasets and allowed for a direct comparison between biotic and substrate classifications using a shared classification framework.
2. Habitat features of the same biotic, substrate, or depth zone type were aggregated, accounting for multiple observations of the same habitat within an MPA.
3. The percentage of each habitat category was then calculated by dividing the aggregated habitat area (step 2) by the total MPA habitat area (step 1).

This process was performed separately for each of the three datasets—biotic, substrate, and depth zones—and resulted in a dataframe for each, containing the percentage cover of unique habitat categories within a given bio-region. A validation check was implemented to warn the user if any calculated percentages fell outside the expected range of 0–100%. Once the data passed this quality check, visualizations were generated to illustrate habitat composition across bio-regions.

The same workflow was then applied to the biotic, substrate, and depth zone datasets outside of MPAs, using the corresponding RDS files for each bio-region.

Statewide Analysis

For this analysis, we compared habitats inside MPAs along the California coast to all available habitat data across the entire California coast. Specifically, this involved comparing: all biotic, substrate, and depth zone data inside MPAs, and all biotic, substrate, and depth zone data across the full coastline, including both protected (MPA) and unprotected areas.

All MPAs

For the analysis of all MPAs statewide, the same workflow described above was followed, with the RDS file generated from the statewide analysis for biotic and substrate data.

California Coast

To analyze habitat composition along the entire California coastline, the same workflow was applied using the initially generated RDS files, which include biotic and substrate data for both inside and outside of MPAs.

Estuary Analysis

The PMEP estuary dataset was unique in that the habitats were pre-defined, although they maintained alignment with the CMECS outline. Some examples of ecosystems found in the estuary habitat data are riverine estuaries, lagoonal estuaries, and embayments/bays, all of which are composed of more than a single biotic component. For this dataset, while the process was largely similar to that of the PMEP California biotic components, the geometry type was different (a multisurface geometry) and had to first be converted to multipolygons to allow for area calculations to be made once reprojected. The estuary data was not appended to the original PMEP Biotic components set, but has its own analysis section as it is considered a habitat type of crucial importance to our clients. However, it was included in final biotic coverage in the cumulative biota table contained in the final chapter of our report.

Eelgrass Analysis

The PMEP eelgrass dataset largely followed the standard and conventions of the PMEP Biotic Components layer, however, eelgrass type (species) was not specified in accordance with typical convention (such as CMECS_BC_Subclass) but rather using CMECS_BC_Code, which related each of the three unique species (*Zostera marina*, *Zostera pacifica*, and *Zostera japonica*) as codes. While dwelling on this classification methodology and the difficulty of determining which species went with each code, it was brought to our attention that perhaps this information was purposely encoded to prevent eelgrass harvesting, as eelgrass beds have historically been exploited in California. For these reasons, we decided to group the data by AreaType instead of species code, which simply put the data into either the “estuary” or “nearshore” categories. All other area calculations were performed in accordance with other PMEP datasets.

Biota Deeper Than 200m Analysis

The deep sea biota dataset, obtained from NOAA’s ‘Deep Sea Coral Initiative’ dashboard, contained point data alone, and therefore was not conducive to area coverage analysis. Instead, total observations at the statewide and bioregion level were recorded, and percent composition of the whole was determined at the common vernacular category level (which contained the most useful identifying information at a short glance, while conserving the total number of categories). This data set was added to supplement the PMEP biotic components, which did not sample below 200 meters depth.

Tools, Libraries, and Infrastructure

A variety of R packages were used as part of the analysis, including spatial data handling, statistical analysis, and visualization. A detailed description of each R package used is provided in Table 2.

R Package(s) & Version	Citation(s)	Use
tidyverse (2.0.0): includes dplyr (1.1.3), tidyr (1.3.0), ggplot2 (3.4.4)	Wickham et al., 2019; Wickham et al., 2023; Wickham, 2016	Cleaning, data wrangling, tidying, plotting
janitor (2.2.0)	Firke, S., 2023	Cleaning column names, tabulations
here (1.0.1)	Müller, K., 2020	File path management
sf (1.0.14)	Pebesma, E., 2018	Reading, manipulating spatial vector data
terra (1.7.55)	Hijmans, R., 2016	Handling raster data
stars (0.6-4)	Pebesma & Bivand, 2023	Spatiotemporal raster/vector data cubes
shiny (1.7.4), shinydashboard (0.7.2)	Chang et al., 2022; Chang & Borges Ribeiro, 2021	Interactive web applications (dashboards)
shinyWidgets (0.8.1)	Perrier et al., 2024	Enhanced UI components for Shiny
shinycssloaders (1.0.0)	Attali, 2021	displaying loading animations while outputs render
leaflet (2.2.1)	Cheng et al., 2023	rendering interactive maps
fresh (0.2.0)	Kassambara, 2020	Customizing UI themes and styles within the Shiny app.
tmap (3.3-3)	Tennekes, M., 2018	Thematic mapping of spatial data
gt (0.10.0)	Iannone et al., 2023	Creating beautiful, publication-ready tables
ggtext (0.1.2)	Wilke, C., 2020	Improved text formatting in ggplot2

Table 2. Summary of all R packages used in this project, including package names, citations, and their specific use cases in the analysis.

Version control of this project was managed on Github, using repositories within the [MarineBioMaps GitHub Organization](#). All statistical and geospatial data generated during the project was stored locally and on a server hosted through the Bren School of Environmental Science & Management at UCSB. In the report generation phase of our project, all relevant analysis, report writing, and the GitHub repository housed in our GitHub organization was given to the client and collaborators. The interactive dashboard will be given to the client, who will host the dashboard on their project servers following the MBM team's graduation. Interactive dashboard code will be archived even if it is not currently being hosted by the clients or Bren school servers. All data used for this project is publicly available, with links provided in our open-source Github repository. The report we generated is intended for use by the client and collaborators.

Results Report

Statewide Analysis:

Overall, the greatest disparity in habitat representation (difference in statewide versus within MPA abundance) was for estuary coverage, at around 9.54% less coverage in the MPA network than in state waters. After this, the second largest difference is in kelp coverage, which was around 0.46% more coverage in the MPA network than in state waters.

An interesting observation was that aquatic vegetation beds appeared to have more representation than benthic biota or faunal beds. More information on biota, substrate, and depth zone distribution and abundance can be found in the results section of our report.

With no deep sea observations found in the PMEP datasets, and incongruent sampling methods for the NOAA Deep Sea Coral Initiative data set, we were unable to collect deep sea area information. However, we did have evidence of deep sea biotic communities, with sponges contributing over 20% of all observations. This, coupled with the fact that deep water zones make up the majority of MPA area, would lead us to advocate for more sampling of MPAs habitats at depths greater than 200 meters.

In comparison to data from the 2016 Master Plan, our findings reported less eelgrass and less deep sea habitat, but much more kelp coverage.

We also conducted a brief biotope analysis, looking at the prevalence of canopy forming macroalgal cover on the two most common substrate types: unconsolidated, and rocky. We decided on this analysis due to interest from our

clients, but also in response to the higher coverage of unconsolidated substrate in MPAs than in statewaters. Since MPAs had higher biota coverage overall, we wondered if perhaps there were higher amounts of kelp on less rocky regions (unconsolidated mineral substrate has less than 50% rock) than on fully rocky regions. However, our results showed that kelp had slightly higher prevalence on rocky substrate (substrate with over 50% rock coverage) which is to be expected in terms of kelp physiology. This may imply that increased unconsolidated mineral substrate has either no correlation to increased biota prevalence, or that another biotic category or categories are contributing to this result.

Bioregion Analysis

The South Coast Study Region had the most biota of all the regions, in both the MPAs and regionwide, but had the lowest percent coverage due to its large size. It also had the greatest habitat diversity of any region, and was the only one with significantly less kelp coverage than would be proportional to statewaters. The Central Coast Study Region had both the second highest biota abundance, and had the closest representation to state waters, in terms of total biota area coverage. The region with the second highest biota diversity, however, was the North Central Coast Study Region. More information on biota, substrate, and depth zone distribution and abundance in the bioregions can be found in the results section of our report.

When considered in tandem with habitat analysis done by Marine Protected Area working groups in the past, in particular with the 2016 Master Plan for MPAs generated prior to the Marine Protected Area Decadal Review, our analysis can be a tool to provide stakeholders with a more comprehensive view of the habitats that make up the California Coast, both within MPAs, and outside of MPAs.

Product Description

To provide MPA working groups with a way to access the results generated in this analysis, a dashboard housing a series of interactive maps and the downloadable report was developed.

The primary function of this dashboard is to provide a convenient webpage from which the official report generated by the MarineBioMaps team can be downloaded. The secondary function is to house the interactive maps. These maps will not show the entire breadth of the analysis, but will provide users with an interesting and engaging way to interface with the data used to complete the full analysis. Specifically, users will be able to select a map of a region of interest, and then toggle on map variables of interest, such as biota distribution.

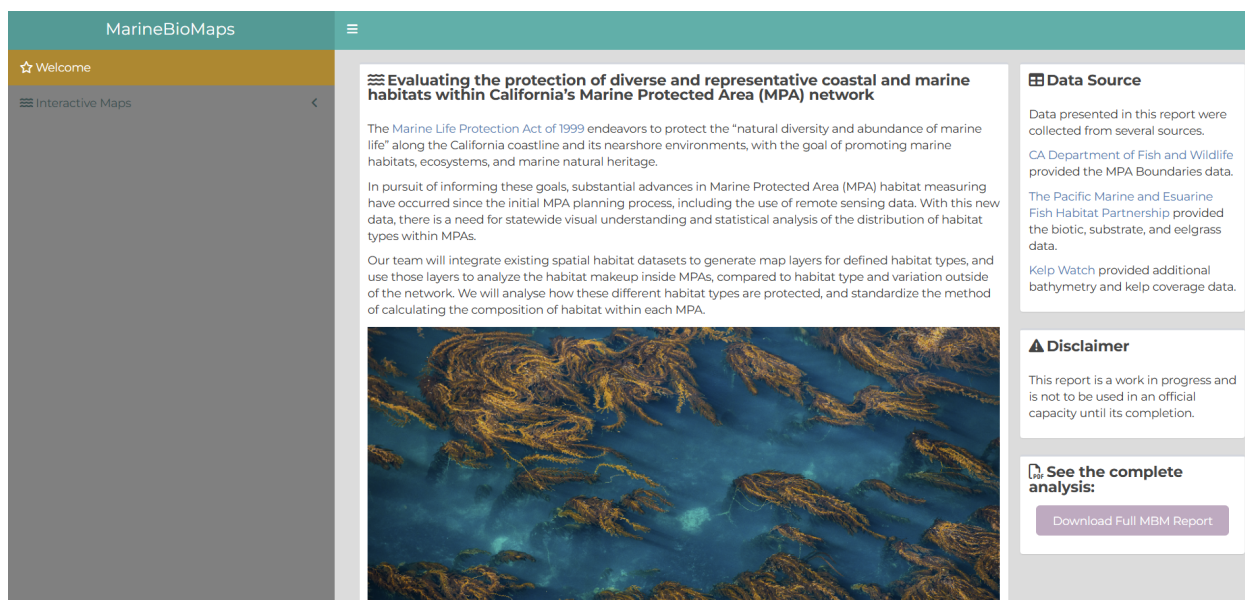
Due to the large and highly complex nature of the datasets used, there can occasionally be longer loading times (up to 30 seconds) for the generated maps. However, by directing users to first select a region of interest, the loading time is reduced, as the scope of the search is more limited.

The primary intended audience for the dashboard, as mentioned above, are the client and affiliated MPA working groups. There are no plans at this point to host the dashboard on a public facing server.

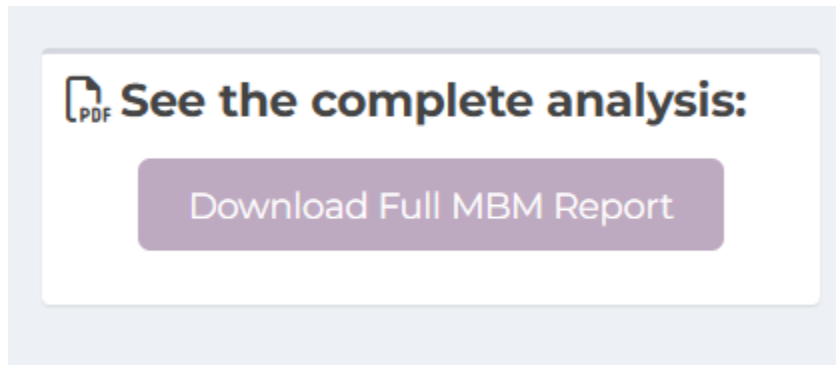
User Manual

Upon receiving a link to the Shiny dashboard that houses our interactive map, our clients will be taken to the “Welcome” or home page of the MarineBioMaps Dashboard. As it is solely a web-based application, there are no specific dependencies or software required to access the dashboard from the web. Standard web browsers such as Chrome, Safari, and Firefox have proven sufficient to observe the contents of the dashboard.

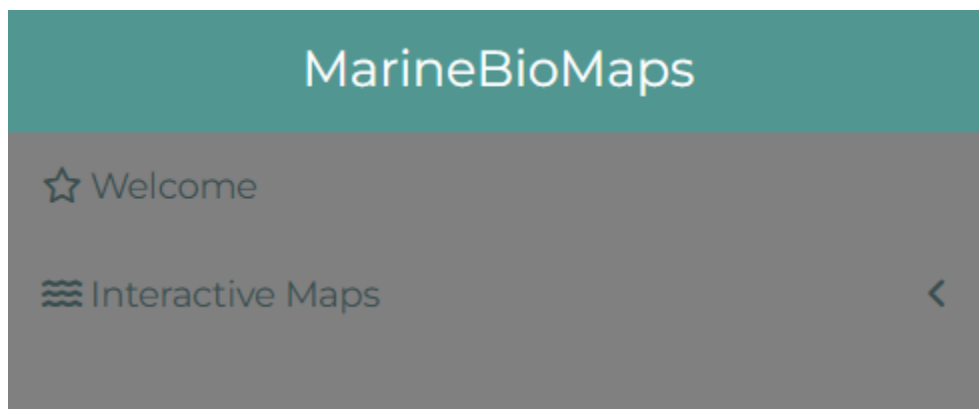
If users want to use the code housed in the MarineBioMaps Github repository to launch the dashboard using R, they will need to have the following libraries installed: shiny, shinydashboard, shinyWidgets, tidyverse, leaflet, shinycssloaders, fresh, sf, and janitor. The R Version used to run this dashboard initially is [check R version and insert here]. Note that the create-fresh-theme.R script must be run before the app itself is run, in order for the custom theme to be applied.



From this homepage, users have two options aside from reading the informational text. They can either click the pink button in the lower right hand corner, or click on the “Interactive Maps” side panel.

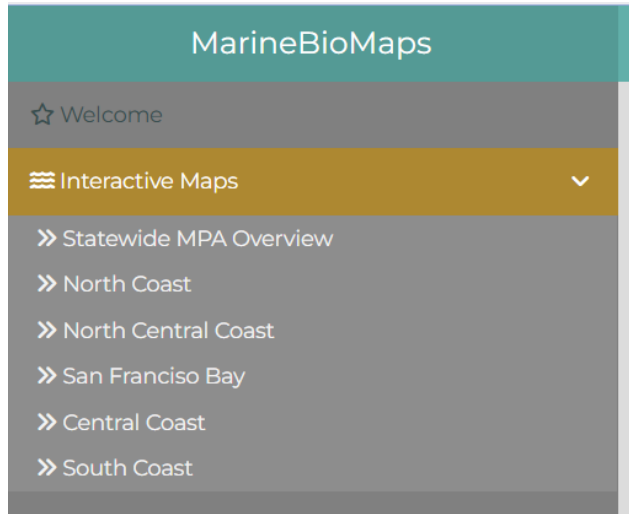


When users click on this button, located in the lower right corner of the dashboard, a new tab is opened in their browser that contains the full and completed report generated by Team MarineBioMaps. This is where users should go if they want to see the complete analysis, including accurate calculations and additional informative visualizations.

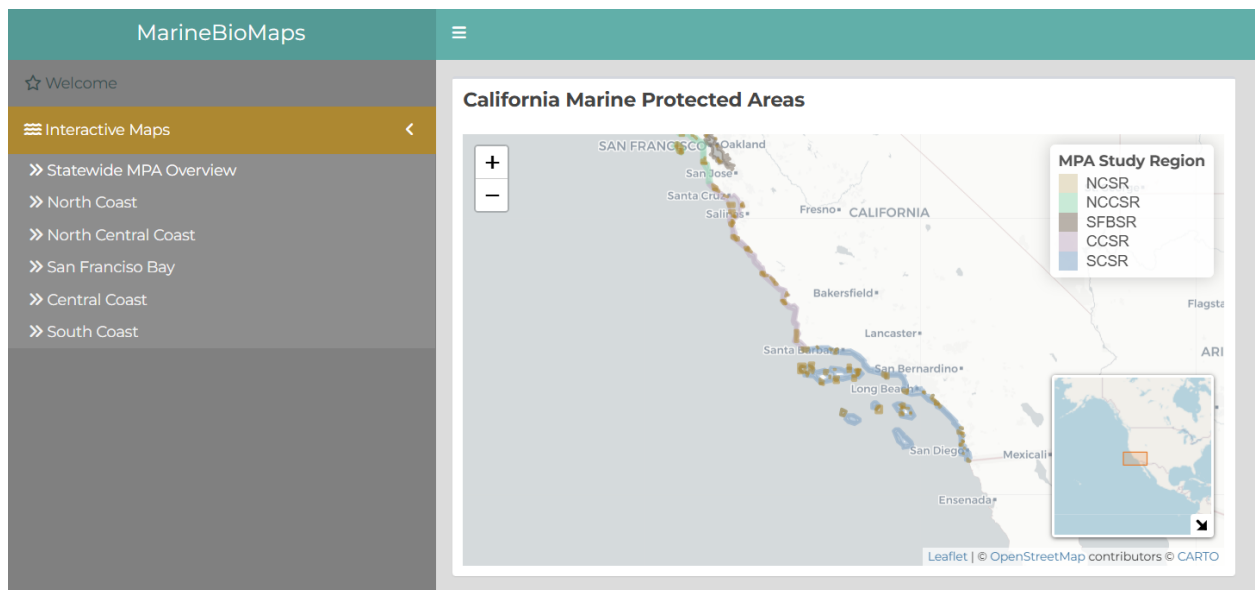


If users click the Welcome button exhibited on the side panel, they will be returned to the home page. Or, if they have not left the home page, nothing will happen.

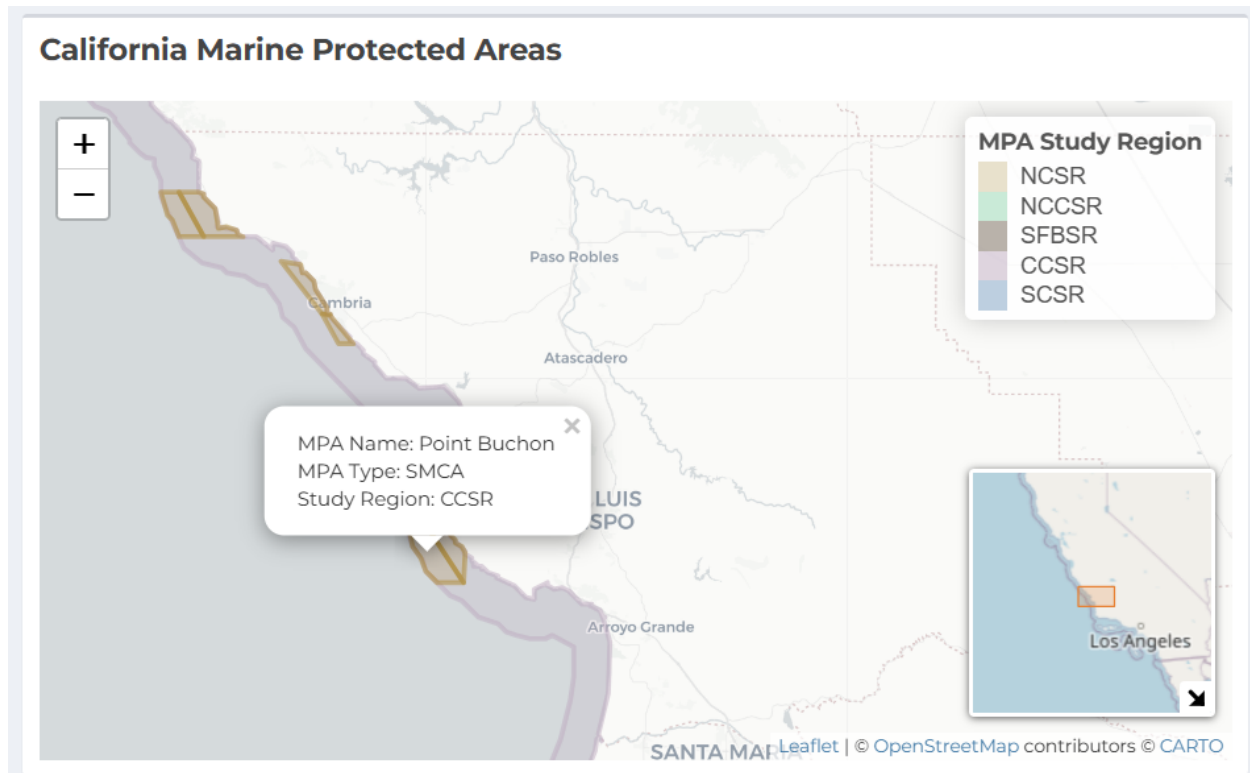
If users click on the “Interactive Maps” option, a dropdown menu will appear like so:



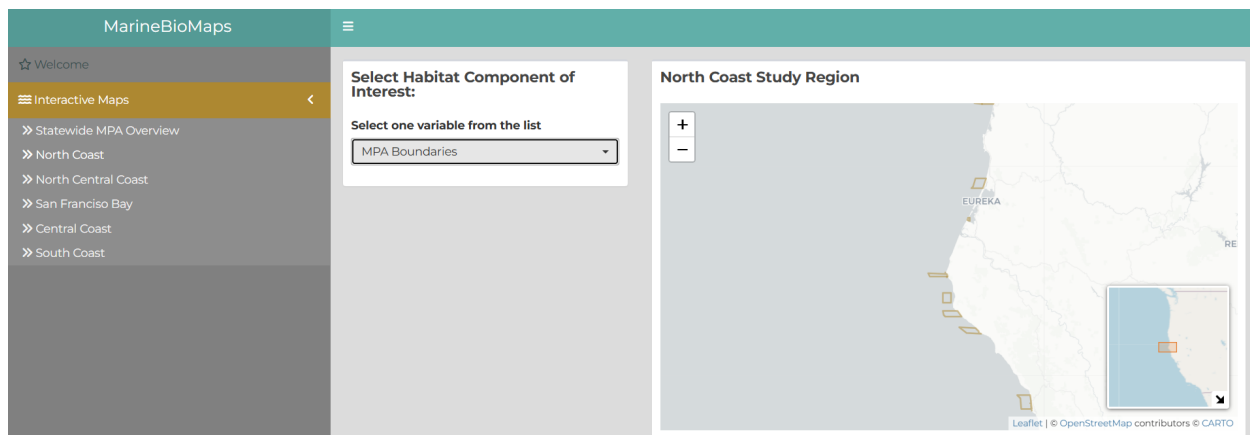
From here, users can click on the region they are interested in examining further.



The Statewide MPA Overview map appears as so, with more descriptive text on the right. The user can use the + and - signs to zoom in and out on the map, examining which regions and which MPAs they are interested in. Clicking on an MPA or the region around it will give them an informational pop up with specific descriptive text, like so:



The regional maps, listed on the dropdown menu under the Statewide MPA Overview Map, have the additional features that the user can toggle on and off. Upon selecting a region, the default map shown will simply be on of the MPA boundaries within that region, like so:



But, from here, users can select from the list a habitat component of choice, to render the appropriate corresponding map. Here is an example of the drop down menu:

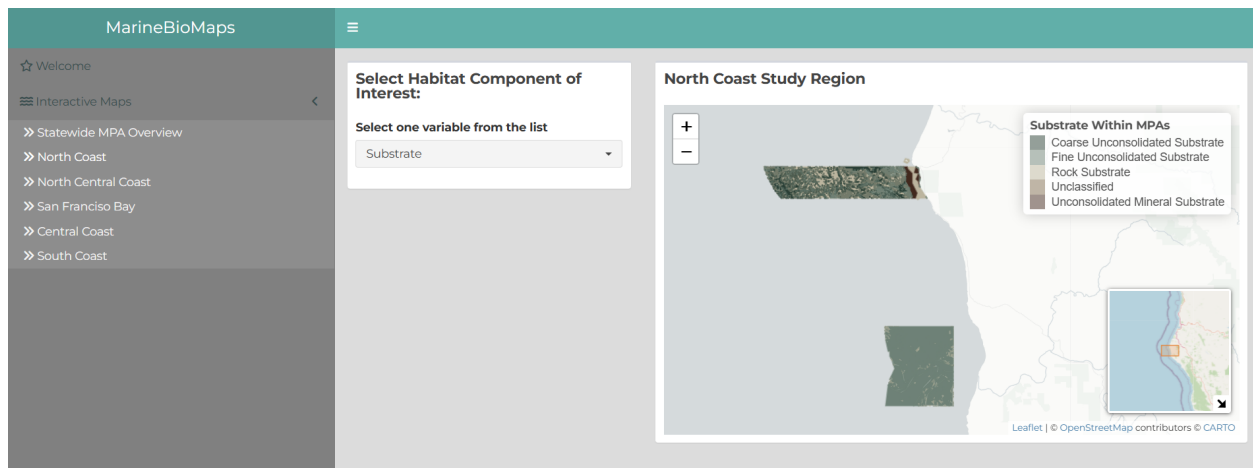
Select Habitat Component of Interest:

Select one variable from the list

Substrate

MPA Boundaries
Biota
Substrate
Depth Zone
Estuary

And here is an example of of a user who has selected substrate as their component of choice, for the North Coast Region:



Archive Access

The official report was delivered to the client through a shared Google drive. Data used for the development of the dashboard and report are documented in the official report, with links to all data used redundantly provided via the dashboard. The MarineBioMaps [GitHub organization](#) with associated repositories houses the working and final data products. A README.md containing further documentation and information on data will be an integral part of the Github organization. The interactive map and dashboard are temporarily being hosted on the Bren server. The code to run the dashboard and interactive map will be provided to the client, who may choose to continue hosting the dashboard live upon Team MarineBioMaps graduation.

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