Building and Maintaining a Comprehensive Database and Prioritization Scheme for Overlapping Habitat Data – Focus on Abiotic Substrates in the Hawaii-Southern California Training and Testing Study Area

Prepared for:

Prepared by:

Introduction

Geographic information system (GIS) data sources available within the Hawaii-Southern California Training and Testing (HSTT) study areas are variable in location, resolution, classification criteria, and accuracy. To ensure that best available data is used in the Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) analyses, an existing database was updated to include data fields for habitat feature classes (e.g., primary mapping method, validation methods, spatial resolution), which helped prioritize these data sources. Prioritizing data sources allows higher quality data to be used over lower quality data where they overlap. The resulting refinement of "surveyed" habitat areas better reflect where different bottom types occur, improving the impact analysis within the Phase III HSTT EIS/OEIS. The habitats resource section in the HSTT EIS/OEIS focuses solely on abiotic substrates with other resource sections focusing on the associated biota (e.g., vegetation, invertebrates). Therefore, the information included herein to classify habitat data is limited to what is biologically relevant (in terms of taxa habitat affinities), stressor sensitive (e.g., crater formation, burial of expended materials), and distinguishable using available mapping techniques.

The HSTT Benthic Habitat Database was developed to refine and prioritize overlapping habitat data used in the analysis of impacts (e.g., military expended materials (MEM) and bottom explosives). The database includes numerous data sources, ranging from broad- to fine-scale, that are combined to create a non-overlapping mosaic of habitat information that presents only the highest quality data for a given location. The database includes primarily polygons features, but also line and point features for selected habitat types (e.g., artificial substrate). The current database is limited to abiotic substrate types assessed in the Chapter 3 Habitats section for the HSTT Phase III EIS/OEIS. This document provides a detailed description of the database and the ranking scheme used to prioritize data for the analysis in the HSTT EIS/OEISs.

Classification System

Although this report focuses on abiotic substrate, other themes or dimensions of aquatic habitat (for which the prioritization scheme may also be applied) provide important context. Figure 1 presents a standard classification scheme for aquatic habitat dimensions that is very similar to the Federal Geographic Data Committee (2012) standard. The Federal Geographic Data Committee standard was not exclusively employed because a "Substrate" component can overlap a "Biotic" component (e.g., live hard bottom organisms growing on either rock or limestone substrate) and the dimensions should be inherently non-overlapping (e.g., water flow/quality vs. abiotic substrate) though they can be correlated at any given location (e.g., hard substrate on high relief features of the bottom). Within the abiotic substrate dimension of habitat reported on this document, overlapping data is ranked based on quality. Abiotic substrate forms the surface of bathymetric features (e.g., outcrops, ridges), and may have associated biotic features (e.g., seaweeds, corals, sponges, mussels). Water flow/quality (e.g., water column) has both horizontal (e.g., surface currents) and vertical dimensions (e.g., temperature stratification) with associated biotic features (e.g., Sargassum mats, phytoplankton biomass). Water flow/quality and biotic features associated with various habitats are analyzed in their respective chapter in the EIS/OEIS (e.g., Sediments and Water Quality, Vegetation, and Invertebrates), and are not included in this report. This report only provides the processing of data sources used to map abiotic substrate types in the HSTT study area.

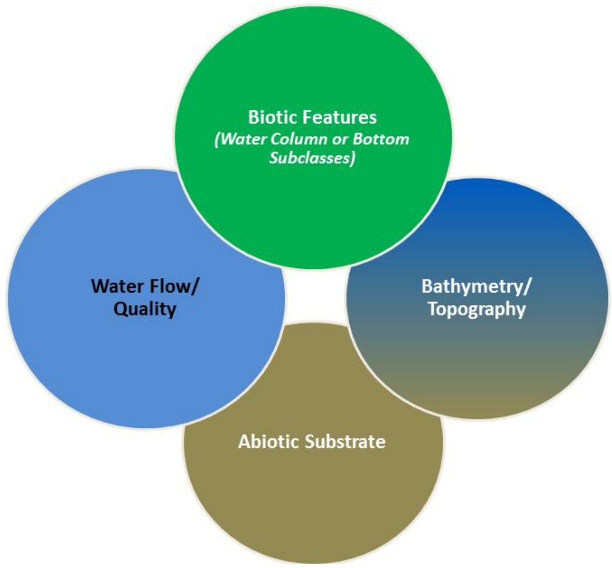

Figure 1. Basic thematic/dimensional aquatic habitat classification scheme. The different circles represent the different themes or dimensions of aquatic habitat that can overlap (e.g., water flows over the substrate but surface substrate types should be non-overlapping).

Abiotic substrate is defined as the non-living material forming the topography of a submerged surface. Although many classification schemes are available that span a range of spatial dimensions and granularity (Allee et al., 2000; Cowardin, Carter, Golet, & LaRoe, 1979; Federal Geographic Data Committee, 2012; Kendall et al., 2001; Kennedy, Green, & Clarke, 1987; United Nations Educational Scientific and Cultural Organization, 2009; Valentine, Todd, & Kostylev, 2005), three types of abiotic substrates are generally based on the grain size of unconsolidated material and degree of consolidation: “soft”, “intermediate”, and “hard” substrates. Soft substrate areas are dominated by mud (including clay and silt) or sand – substrate often too unstable for colonization by habitat-forming sedentary invertebrates (e.g., hard corals, oysters) or attached seaweed. Hard substrate areas are dominated by rocks or consolidated bedrock that is stable enough for colonization by habitat-forming sedentary invertebrates or attached seaweed. Intermediate substrate areas are dominated by unconsolidated material larger than sand but smaller than rocks (e.g., gravel). These areas may or may not be stable enough for habitat-forming sedentary invertebrates or attached seaweeds. Artificial substrate (e.g., shipwrecks, artificial reefs) is another type of abiotic substrate that is based on material type and origin. Spatial and temporal variation in abiotic substrate is created by the interplay of surficial geology, currents, and water quality at a location.

Data Source Qualities

The Navy acquires data mapping aquatic habitats from various government (federal, state, and local) or private sources including but not limited to the National Oceanographic and Atmospheric Administration (NOAA), United States Geological Survey (USGS), Bureau of Ocean Energy Management (BOEM), state resources management agencies, government-funded marine laboratories, and private contractors working on projects with a federal nexus. The Navy has also conducted its own bottom mapping for specific projects and created some datasets based on expert knowledge of selected features (e.g., hard bottom on shelf break ridge and seamounts). The data sources are references in the section entitled "Summary of Data Sources." The mapping data sources were compiled and qualities of the data were documented in a database. Microsoft Access was used to create a form for documenting the variables needed to rank data quality (refer to section titled "Data Quality Ranking Scheme" for details). The data table can also be linked to an ArcGIS geodatabase for mapping sources to query for data quality attributes.

<u>Description of Fields in Database Tables</u>

1. Source/Text Citation Table
    a. Source/Text Citation – shows how data source would be cited in text and links to "child" table for habitat dimensions/feature classes table
    b. Basic Metadata/Literature Cited – Full bibliographic citation for source
    c. Multi-dimensional – Check if the source mapped multiple dimensions of habitat (e.g., bathymetry/topography, abiotic substrate, and biotic features)
2. Habitat Dimensions/Feature Classes Table
    a. Map_id – unique identifier linking GIS data with Access record
    b. Text Citation – shows how data source would be cited in text and links to "parent" table for source references
    c. Habitat Dimension/Feature Class (pick only one – a single source can have multiple features classes and geometries)
        i. Bathymetry/Topography – selected if the feature theme(s) depicts depth of the water column or topographic features of the bottom (e.g., outcrops, shelf breaks),
        ii. Abiotic Substrate – selected if the feature theme(s) depicts a substrate classification (e.g., silt, sand, gravel, cobble, boulder/bedrock)
        iii. Biotic Features – selected if the feature theme(s) depicts a biological feature of the water column or bottom (e.g., floating macroalgae mats, seagrass beds, reefs)
    d. Geometry – specify if feature class is represented by point, line, polygon, or raster geometry
    e. Year Data Collected– this is the year(s) that mapping data was collected (in the field) by the source reference and not necessarily the year of publication. The data could be a range (data for every year), multiple non-consecutive years, or a single year.
    f. Method (Mapping) – methods that cover largest area of mapping theme
        i. Acoustic Sensor – includes use of devices that detect sound reflectance (e.g., sidescan sonar, single or multi-beam vertical sonar, sub-bottom profiler)

ii. Bathymetry – reference to bathymetry from navigation charts (typically combined with modeling/interpolation using validation methods)
iii. Benthic Sampler – includes use of devices that extract a sample of the bottom composition, including sedentary or very slow-moving organisms (e.g., benthic grab, sediment core, dredge)
iv. Expert Knowledge – includes use of hand-drawn or digitized boundaries based on expert knowledge
v. Modeling/Interpolation – Typically a combination of bathymetry, expert knowledge and some validation data in the form of points, lines, and/or polygons that do not cover the entire study area
vi. Nekton Sampler – includes use of devices that captures large mobile organism in the water column or on the bottom (e.g., trawl, trap). Some organisms can be indicators of persistent aquatic habitat features (e.g., hard bottom).
vii. Other sensor – includes any technology not specifically covered by the specified methods (e.g., magnetometer).
viii. Plankton Sampler – includes use of devices that capture tiny organisms drifting in the water column
ix. Point-based Interpolation – includes polygons interpolated among point samples
x. Visual Observation (direct) – includes direct observation by divers or use of device that captures video or photographic footage at a resolution similar to direct observation by divers (e.g., underwater video camera, remotely operated vehicle)
xi. Spectral Sensor (remote) – includes use of devices that detect some part of the light spectrum from a remote platform (e.g., aerial photography, satellite multispectral scanner)
xii. Water Flow/Quality Meters – includes use of devices that measure flow velocities or water quality parameters (e.g., temperature, salinity, turbidity, dissolved oxygen)

g. Method (Validation) – methods used to validate classification by the primary method (see mapping methods for listing)
h. Validation Coverage (%) – percentage of the mapping area covered by the validation method
i. Minimum Mapping Unit (m) – smallest area or resolution of the mapped classifications
j. Assemblage Data –selected if the data represents a compilation of different sources
k. Subset Data – selected if the data represents a subset of a series of mapping sources
l. Acquisition Status – status with regard to acquiring the spatial data.
m. Data Rank by Theme(s) – a ranking from 0 (lowest quality) to 100 (highest quality) for the sources mapping a feature theme(s) in the database - See section below (Data Quality Ranking Scheme) for more information.
n. Data Preparation/Processing Notes – Documentation for the conversion of data source classification into standard abiotic substrate categories.

Description of fields included in GIS shapefile data for abiotic substrate types:

1. Map_id – links to identical field in database (e.g., rank data quality)
2. Feat_name – "abiotic substrate types"
   o. Soft – mud (clay or silt), sand
   p. Intermediate – gravel, cobble; or fine-scale mixture of soft and hard
   q. Hard – rock/boulder, bedrock
3. User_flag (Artificial – subcategories): ship wreck, artificial reef, oil/gas platform, offshore military tower, or wind turbine
4. Acres

Data Quality Ranking Scheme

Each source of polygon data was given a rank from 0 (lowest quality) to 100 (highest quality) in order to determine the highest quality data in a given location, which was then used for subsequent analysis. The rank is based on a combination of minimum mapping unit (i.e., mapping resolution), mapping and validation method(s), compatibility of native classification system, and noted adjustments. Qualities of the datasets used to supporting the qualitative rankings are provided in Appendix B.

Mapping resolution is straight forward in terms of superiority: smaller minimum mapping units provide a better resolution of data. The minimum mapping units are ranked from 1 (lowest resolution/largest minimum mapping unit) to not greater than the number of datasets (highest resolution/smallest minimum mapping unit) if all the minimum mapping units are different. Data sources with equal minimum mapping units are given the same rank for mapping resolution.

As a comparison of mapping and validation method(s), consider a typical point-based interpolation compared to a highly detailed multibeam sonar, benthic grab, and remote operated vehicle (ROV) survey. When data are available for the same location, the highly-detailed survey data (with a higher ranking score) would be used in the non-overlapping mosaic. Although, point-based interpolation data could be better than multibeam sonar if the points were close enough together, multibeam sonar data is generally considered to be of higher quality. The mapping and validation methods are ranked from 1 to 4, with four being the highest and best methods.

1. Point-based interpolation using benthic sampler validation or bathymetric interpolation and expert knowledge;
2. Line-based interpolation (e.g., depth or reflectance profiles) and validation by direct visual observation;
3. Bathymetric interpolation/modeling using validation from acoustic sensors, benthic samplers and direct visual observations or acoustic sensor/remote spectral sensor without validation; and
4. Acoustic sensor or remote spectral sensor using validation from direct visual observation or benthic samplers

Compatibility of native classification system was ranked from 1 (lowest rank) to 3 (highest rank) based on the following descriptions of original bottom type classifications:

1. Bottom classifications are all geologic indicators of abiotic substrate types;
2. Bottom classifications can be directly translated into standardized categories or there is a strong correlation of stationary biota (e.g., hard corals, live hard bottom organisms) to a set of factors including hard substrate;
3. Bottom classification can be directly translated into standardized categories and there is reference to topography (e.g., high relief hard bottom) and relatively high concentration of stationary biota.

The component ranks are combined to yield a total rank from 0-100 using the following equation, assuming 50% is based on resolution, 30% on mapping and validation methods, and 20% on compatibility of native classification system. A bonus or penalty may also be added for additional factors considered for overlapping data.

$$(R/RH*50) + (M/MH*30) + (C/CH*20)$$

R=Resolution rank for individual source x
RH = Highest rank for resolution in the dataset
M=Methods rank for individual source
MH=Highest rank for method in the dataset
C=Classification rank for individual source
CH = Highest classification rank in the dataset

Summary of Data Sources

For the HSTT study area, there were 4 point data sources and 6 polygons data sources (including sources integrating numerous constituent data sources; Table 1). Note that equivalent ranks are allowed where polygon data sources do not overlap.

Table 1. Mapping data source for abiotic substrate types in the HSTT phase III study area.

Geometry	Source	Data Rank (0-100)	Description (Rank Components)
Point[1]	(California Department of Fish and Wildlife, 2015)	NA	Mapped points representing artificial reef centroids
	(California State Lands Commission, 2012)	NA	Mapped points representing shipwreck locations, but deleted points coincident with NOAA (2015)
	(Hawaii Division of Aquatic Resources, 2015)	NA	Mapped points representing artificial reef centroids
	(National Oceanic and Atmospheric Administration, 2015)	NA	Mapped artificial only (limited to shipwreck, rocky outcrop and unknown object locations regardless of accuracy)
Polygon	(Bauer et al. 2016)	64.6	Digital data: Predictive models of deep-sea coral habitat suitability in the Main Hawaiian Islands (Resolution 3, Methods 3, Classification Compatibility 2, +10 for depicting habitat suitability for deep-sea hard corals)
	(California State University Seafloor Mapping Lab, 1987)	33.3	California continental shelf geology (Resolution 2, Methods 1, Classification Compatibility 2)
	(California State University et al., 2007)	60.8	Predicted Substrate of Southern California (Resolution 4, Methods 3, Classification Compatibility 2)
	(KTU-A Landscape Architecture & Planning, Moffatt Nichol, San Diego Nearshore Habitat Mapping Program, & San Diego Association of Governments, 2002)	67.5	Seafloor Substrate of the San Diego Region Nearshore Coastal Zone (Resolution 4, Methods 3, Classification Compatibility 3)
	(Merkel and Associated 2013)	85.8	Benthic Habitat Mapping in the Silver Strand training area of Southern California (Resolution 8, Methods 3, Classification Compatibility 2)
	(Merkel and Associates, 2014)	80.8	Benthic Habitat Mapping for West Cove Naval Auxiliary Landing Field, San Clemente Island Naval Base Coronado, California (Resolution 6, Methods 4, Classification Compatibility 2)
	(National Centers for Coastal Ocean Science, 2007b)	67.1	Northwestern Hawaiian Island Shallow-water Coral Reef Ecosystem Map Development Procedures (2004-2007 data) (Resolution 5, Methods 3, Classification Compatibility 2)

[1] NA = Not Applicable; Point are not assigned a qualitative rank because they did not precisely overlap.

Table 1. Mapping data source for abiotic substrate types in the HSTT phase III study area.

Geometry	Source	Data Rank (0-100)	Description (Rank Components)
	(National Centers for Coastal Ocean Science, 2007a)	86.3	Mapping of Benthic Habitats for the Main Eight Hawaiian Islands (Resolution 7, Methods 3, Classification Compatibility 3)
	U.S. Department of the Navy (2016) – lowest quality unclassified data	27.1	Unclassified sediment mapping from Naval Oceanographic Office (Resolution 1, Methods 1, Classification Compatibility 2)
	U.S. Department of the Navy (2016) – highest quality unclassified data	40.8	Unclassified sediment mapping from Naval Oceanographic Office (Resolution 2, Methods 2, Classification Compatibility 2)
	Wells et al. (2016)	87.1	Substrate Mapping in the Pearl Harbor Channel (Resolution 7, Methods 4, Classification Compatibility 2)

Description of Non-overlapping Mosaic

Thousands of acres of low quality data were superseded by high quality data in the process of creating the non-overlapping abiotic substrate maps for the HSTT study areas. The process identified substrate distribution within Large Marine Ecosystems, which was used as a basis for the analyses in the HSTT EIS/OEIS. Developing a data quality ranking scheme also allowed for identifying over- or under-estimation of habitat types, by comparing areas of higher and lower quality data. Point and line features were also included in the dataset because they are inherently non-overlapping in terms of area. Refer to Appendix A for regional substrate maps from the HSTT EIS/OEIS (note: linkage between Appendix A and B is the "map_id" field).

Within the HSTT study area, almost 450 artificial substrate points were identified (Table 2), including mostly shipwrecks (355), unknown object (73), and artificial reefs (17). No oil or gas platforms are located in the HSTT study area. The artificial reefs represent permitted area center points. Notable omissions from the artificial substrate points may include wrecks that are "address restricted" due to status on the National Registry of Historic Places and wrecks created from naval sinking exercises. However, the only known omissions of this nature were in the AFTT study area.

The polygon data for abiotic substrate types in the HSTT study area is almost everywhere (Appendix A), though the quality varied widely. The higher quality mapping available for large marine ecosystems (LMEs) of the HSTT study area is confined to shallow margins around the mainland coast, islands and other land features (e.g., atolls). The Pacific Basin Open Ocean Area is mapped with a lower quality dataset (U.S. Department of the Navy 2016) where the bottom is in the abyssal zone where even deep sea corals are not expected (Tittensor et al. 2009). Within the California Current and Insular

Pacific/Hawaiian LMEs, a much greater portion of bottom is classified as hard or intermediate (77-78%) than soft (Table 3). However, percent of bottom area does not account for the vertical relief of some hard bottom areas, which contribute disproportionately to hard bottom community biomass. The distribution of substrate type differs substantially from that of the AFTT study area where soft substrates are predominant.

Table 2. Number and type of artificial substrate points documented in Large Marine Ecosystems of the HSTT study area.

Large Marine Ecosystem	Artificial Reef	Shipwreck	Unknown Object	Grand Total
California Current	12	241	42	295
Insular Pacific/Hawaiian	5	114	31	150
Grand Total	*17*	*355*	*73*	*445*

Habitat Suitability Models

To supplement the mapping surveys, additional data was employed that predict where live hard bottom is very likely based on habitat suitability models for selected deep sea corals (Bauer et al. 2016). The predictions are based on correlating the occurrence of various deep coral species with numerous environmental parameters, including slope and curvature of the bottom. The predictions fill some significant gaps in the suspected distribution of live hard bottom in the deeper waters surrounding the main Hawaiian Islands.

Table 3. Percent coverage of abiotic substrate types in Large Marine Ecosystems and the Pacific Basin Open Ocean Area of the HSTT Study Area.

Large Marine Ecosystem or Open Ocean Area	Percent of Large Marine Ecosystem				Square Km (Total)
	Hard	Intermediate	Soft	Unknown	
California Current	2.27%	75.28%	22.45%	0.00%	318,928
Insular Pacific-Hawaiian	24.87%	53.08%	22.05%	0.00%	970,870
Pacific Basin Open Ocean Area	2.70%	87.24%	10.06%	0.00%	7,117,642
Grand Total	*1.03%*	*1.27%*	*0.34%*	*97.37%*	*8,407,441*

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[2] For sources identified with "[GIS metadata]", no supporting literature or documentation other than GIS metadata is available

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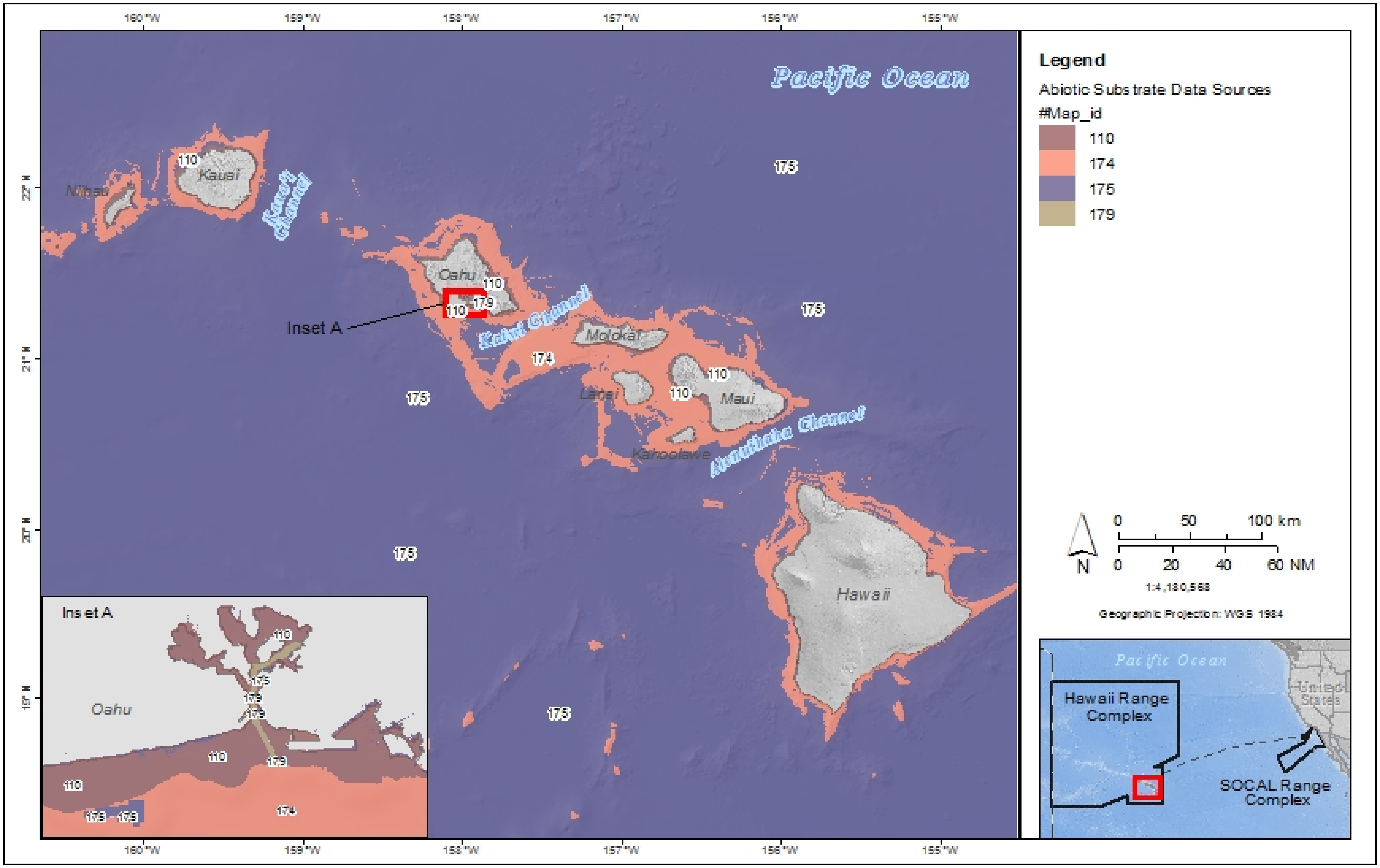
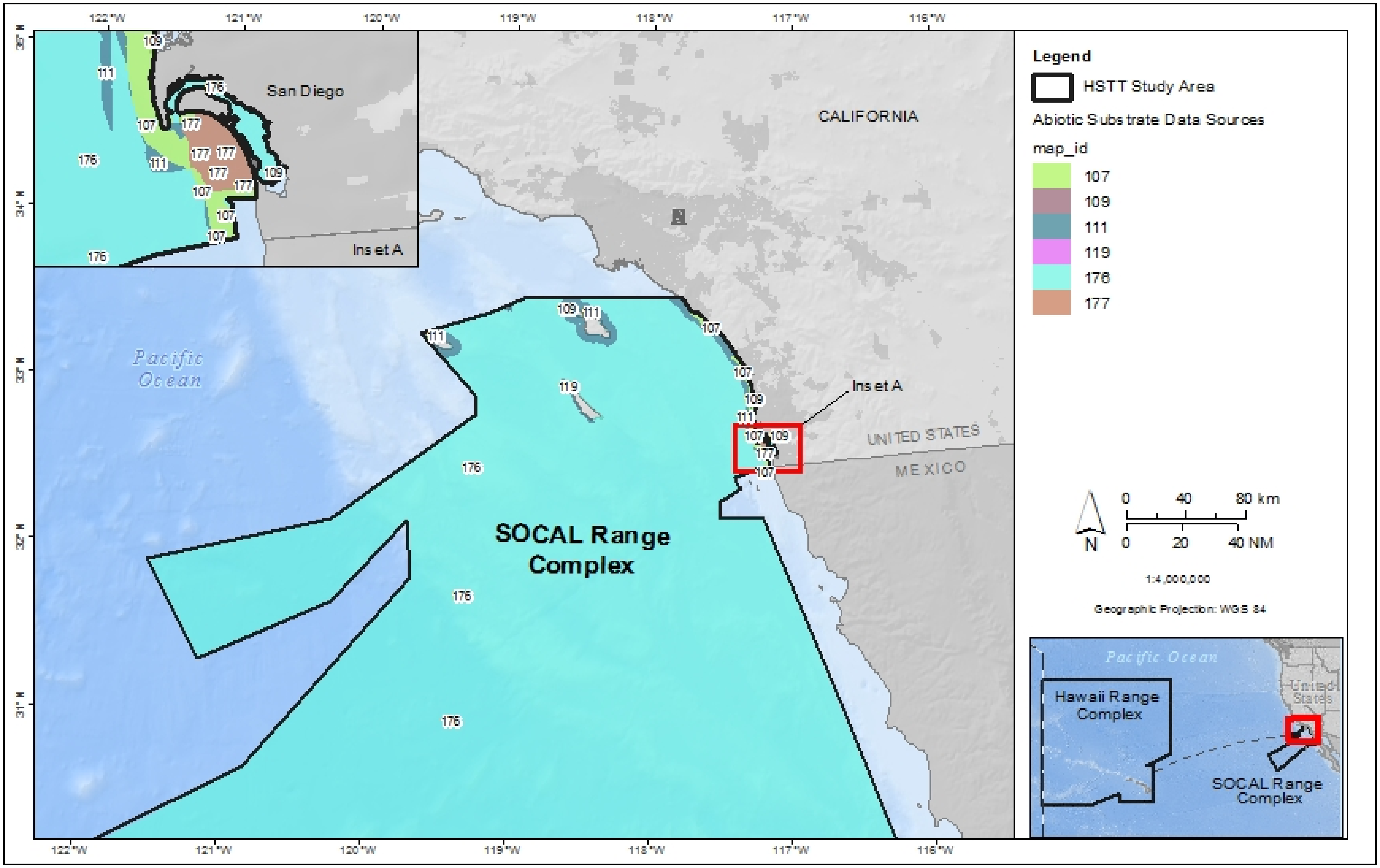
APPENDIX A - Abiotic Substrate Mapping by Region in the HSTT Study Area



Appendix A1. Distribution of benthic habitat data sources in the Southern California Range Complex (refer to Appendix B to link #map_id to more information).



Appendix A2. Distribution of benthic habitat data sources in the Hawaiian Range Complex (refer to Appendix B to link #map_id to more information).

APPENDIX B – Data source qualities supporting rank determinations.

Data Source - #map_id	Year(s) Date Collected	Method (Mapping)	Method (Validation)	Validation Coverage (%)	Min. Mapping Unit (m)	Processing Notes
CSU Seafloor Mapping Lab (1987) - #109	1987	Bathymetry, Modeling/ interpolation	Benthic Sampler	<1	500	AS_type: Hard as BOTTOM = "hard_outcrop/pavement" or "hard_bottom"; Intermediate as BOTTOM = "mixed"; Soft as BOTTOM = "soft_sediment"
CSUMB, USGS, Fugro Palagos, Ocean Imaging, SanDAG, MLML, CDFW (2006) - #111	-2006	Acoustic Sensor, Modeling/ interpolation, Spectral Sensor (remote)			15	AS_type: Hard as 'mapclass' = "Hard"; Soft as 'mapclass' = "Soft"
KTU-A LA and P, MN, SDNHMP, and SanDAG (2002) - #107	2002	Acoustic Sensor, Spectral Sensor (remote)			6	AS_type: Hard as "Bedrock" or "Boulder" or "Kelp Canopy Obscuring Seafloor"; Intermediate as "Cobble" or "Pebble/Gravel/Granule"; Soft as "Sand" or "Mud"; Artificial as "Artificial Substrate"
Merkel and Associates (2014) - #119	2013	Acoustic Sensor	Visual Observation (direct)	<1	3	AS_type: Hard as "Rocky Shore-Spray/Splash Zone" or "Boulder Over Bedrock" or "Bedrock"; Intermediate as "Mixed Sand/Rubble"; Soft as "Sand"
NCCOS (2007) - #127	2004-2007	Spectral Sensor (remote)			10	Hard as "HABCOVER" = 'CCA on hardbottom' OR "HABCOVER" = 'hardbottom, unspecified cover' OR "HABCOVER" = 'live coral on hardbottom' OR "HABCOVER" = 'macroalgae on hardbottom' OR "HABCOVER" = 'uncolonized hardbottom'; Soft as "HABCOVER" = 'macroalgae on unconsolidated' OR "HABCOVER" = "unconsolidated"

Data Source - #map_id	Year(s) Date Collected	Method (Mapping)	Method (Validation)	Validation Coverage (%)	Min. Mapping Unit (m)	Processing Notes
NOAA/NOS/NCCOS /CCMA (2007) - #110	2007	Spectral Sensor (remote)	Visual Observation (direct)	<1	0.6-4	As_type: Hard as 'M_STRUCT'="Coral Reef and Hardbottom"; Soft as 'M_STRUCT'="Unconsolidated Sediment"; Artificial as 'D_STRUCT'="Artificial" AND 'ZONE' <> "Land"
Bauer et al. (2016) - #174	-2016	Bathymetry, Modeling/ Interpolation	Acoustic Sensor, Bathymetry, Benthic Sampler, Plankton Sampler, Visual Observation (direct), Water Flow/Quality Meters	<1	400	Converted rasters for deep-sea coral probabilities (0-14 scale) into polygon shapefiles and combined species shapefiles with only the top 75% ranking (>10). The genera included represent precious and stony coral species associated with hard substrate: black corals, gold corals, pink corals, bamboo corals, and frame-building stony corals.
U.S. Department of the Navy (2016) - #175 (lower quality) & 176 (higher quality)	-2016	Bathymetry, Expert Knowledge, Modeling/ Interpolation	Benthic Sampler	<1	>1000	AS_Type: Hard as "LABEL_1" = 'Calcareous Coral' OR "LABEL_1" = 'Calcareous Rock' OR "LABEL_1" = 'Calcareous Rock - Coral' OR "LABEL_1" = 'Hemipelagic Calcareous Rock' OR "LABEL_1" = 'Hemipelagic Calcareous Rock - Coral' OR "LABEL_1" = 'Hemipelagic Terrigenous Rock' OR "LABEL_1" = 'Terrigenous Rock' OR "LABEL_1" = 'Volcanic Boulders' OR "LABEL_1" = 'Volcanic Rock' OR "LABEL_1" = 'Hemipelagic Calcareous Rock - Sand - Mud' OR "LABEL_1" = 'Calcareous Rock - Sand - Mud' OR "LABEL_1" = 'Calcareous Rock - Sand' OR "LABEL_1" = 'Terrigenous Rock - Gravel - Sand' OR "LABEL_1" = 'Calcareous Rock -

Data Source - #map_id	Year(s) Date Collected	Method (Mapping)	Method (Validation)	Validation Coverage (%)	Min. Mapping Unit (m)	Processing Notes
						Gravel' OR "LABEL_1" = 'Calcareous Rock - Gravel - Sand' OR "LABEL_1" = 'Pelagic Calcareous Marl'; Intermediate as "LABEL_1" = 'Calcareous Coral Debris' OR "LABEL_1" = 'Calcareous Coral Debris - Mud - Shell' OR "LABEL_1" = 'Calcareous Gravel - Sand' OR "LABEL_1" = 'Calcareous Gravelly Sand - Shell' OR "LABEL_1" = 'Hemipelagic Calcareous Coral Debris' OR "LABEL_1" = 'Hemipelagic Calcareous Coral Debris - Sand' OR "LABEL_1" = 'Hemipelagic Calcareous Coral Debris - Sand - Mud' OR "LABEL_1" = 'Hemipelagic Calcareous Coral Debris - Sand - Shell' OR "LABEL_1" = 'Hemipelagic Calcareous Gravel - Sand' OR "LABEL_1" = 'Hemipelagic Calcareous Gravel (Shell Detritus)' OR "LABEL_1" = 'Hemipelagic Calcareous Gravelly Sand - Shell' OR "LABEL_1" = 'Hemipelagic Terrigenous Clay' OR "LABEL_1" = 'Hemipelagic Terrigenous Gravel - Mud' OR "LABEL_1" = 'Pelagic Calcareous Gravel' OR "LABEL_1" = 'Pelagic Clay' OR "LABEL_1" = 'Pelagic Siliceous Clay' OR "LABEL_1" = 'Volcanic Gravel' OR "LABEL_1" = 'Pelagic Calcareous Clay' OR "LABEL_1" = 'Hemipelagic Calcareous Sandy Gravel' OR "LABEL_1" = 'Terrigenous Gravel - Silty Sand' OR

Data Source - #map_id	Year(s) Date Collected	Method (Mapping)	Method (Validation)	Validation Coverage (%)	Min. Mapping Unit (m)	Processing Notes
						"LABEL_1" = 'Calcareous Coral Debris - Sand' OR "LABEL_1" = 'Calcareous Coral Debris - Sand - Mud' OR "LABEL_1" = 'Calcareous Coral Debris - Sand - Mud - Shell' OR "LABEL_1" = 'Calcareous Coral Debris - Sand - Shell'; Soft as:"LABEL_1" = 'Calcareous Clayey Silt' OR "LABEL_1" = 'Calcareous Gravelly Muddy Sand' OR "LABEL_1" = 'Calcareous Gravelly Sand'OR "LABEL_1" = 'Hemipelagic Calcareous Gravelly Muddy Sand' OR "LABEL_1" = 'Hemipelagic Terrigenous Gravelly Sand' OR "LABEL_1" = 'Terrigenous Gravelly Sand'OR "LABEL_1" = 'Terrigenous Gravelly Sandy Silt'
Merkel et al. (2013) - #177	2012	Acoustic Sensor	Acoustic Sensor, Expert Knowledge	100	1	AS_Type: Hard as "boulder/cobble reef"; Intermediate as "coarse sediments/shell hash"; Soft as "sand"; Artificial as "artificial substrate"; Unknown as "unknown target"
Wells et al. (2016) - #179	2015	Acoustic Sensor	Visual Observation (direct)	1	2.5	Converted raster coverages into polygons and classified gridcode ranges to standardized abiotic substrate types: hard = 63-126, intermediate = 126-189, soft = 189-254. The reference indicated that range of gridcode values was essentially a uniform gradient from 0-100% hard or soft.