FINAL REPORT

EARLY IMPLEMENTATION OF NEARSHORE ECOSYSTEM DATABASE PROJECT

TASK 2: Habitat Metadata Catalog (marine habitat substrate data for the California continental shelf not currently held by CDF&G)

TASK 3: Review of Procedures, Protocols, Technologies and Providers for Nearshore Marine Habitat Mapping

JULY 29, 1999

Contractor:

Moss Landing Marine Laboratories

and

California State University, Monterey Bay

via

San Jose State University Foundation Contract # FG 7335 MR

Prepared for:

California Department of Fish and Game

Nearshore Ecosystem Database Project

Compiled by:

Rikk Kvitek, Pat Iampietro, Eric Sandoval, Mike Castleton, Carrie Bretz,

Tally Manouki and Amanda Green

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SIVA Resource Center

Institute for Earth Systems Science and Policy

California State University, Monterey Bay
100 Campus Center, Seaside, CA 93955

(831) 582-3529

rikk_kvitek@monterey.edu

Early Implementation of the Nearshore Ecosystem Database Project Tasks 2 and 3

1. EXECUTIVE SUMMARY AND RECOMMENDATIONS

1.1. BACKGROUND

The California Department of Fish and Game Nearshore Ecosystem Database Project is designed to address the policy of the State to assess, conserve, restore, and manage California's ocean resources and the ecosystem as stated in Executive Order No. W-162-97. The purpose of this project is to enable the Department to expand its Geographic Information System (GIS) database to include and make available to CERES, data from the marine subtidal and nearshore ecosystems. The primary components of the project are: GIS mapping of essential marine habitats, nearshore reef fish stock assessment, and marine reserve research. The Early Implementation Phase of this project has focused on accelerating the acquisition of baseline bathymetry and substrate data as outlined in the GIS Mapping of Essential Marine Habitats portion of the project. This effort has included four tasks:

Task 1) Data Needs: Identification of departmental needs for bathymetry and substrate data.

Task 2) Data Catalog: Assessment and collection of metadata for currently available data on marine bathymetry and seafloor substrates.

Task 3) Procedures, Protocols and New Technologies: A review of current and emerging methods and providers for mapping marine habitats.

Task 4) Data Processing: Process and incorporate existing bathymetric and substrate data into Department GIS coverage themes.

1.2. PURPOSE AND SCOPE

The focus of this report is on those portions of Tasks 2 and 3 subcontracted to Moss Landing Marine Laboratories and California State University Monterey Bay through San Jose State University Foundation (Contract # FG 7335 MR). For Task 2, the work was divided, with the Department taking on the collection and assessment of metadata for bathymetry, and this contract covering the metadata for existing substrate information. For Task 3 our assignment was to survey and evaluate currently available techniques for mapping marine habitats, and to assess their adequacy for meeting stated Department data needs. Here our goal has been to provide the Department with the information needed to make decisions on: 1) how habitats of interest should be mapped given the needs of the Department, 2) the selection of providers of marine habitat mapping services and equipment, and 3) the relative costs in time and money associated with acquiring the types of habitat data needed.

The Department requested that we limit our scope to the California continental shelf, giving primary attention to the nearshore 0-30 m depth zone. It is this shallow coastal zone that is often the most heavy utilized and impacted by human activities, yet it is also the zone for which we have the least amount of bathymetric and substrate data. This data scarcity is due in large part to the challenging and often dangerous logistics associated with conducting hydrographic

surveys in shallow, open coast environments. High use and data scarcities have made the 0-30 m depth zone a high priority for habitat mapping over the next decade.

1.3. FINAL PRODUCTS

Our final products for this project include the written final report and two Microsoft Access databases, one containing information on habitat mapping technologies and providers (Mapping Tools Database), and the other the CERES compliant metadata catalogue for existing seafloor substrate data sets. In the report we review and summarize the reasons for, approaches to and requirements of habitat mapping as they apply to nearshore marine resource management. Also in the report, we review and summarize in tabular form the data contained in the two databases. The Habitat Mapping Tools Database contains information on the Tools, Tool Manufacturers, Survey Equipment Providers, and Survey Service Providers (including private companies, universities and government agencies). The Seafloor Substrate Metadata Catalog contains information on 85 data sets obtained after contacting 86 potential sources.

1.4. SUMMARY

A habitat is the place where a particular species lives or biotic community is normally found. Habitat mapping is often undertaken by resource agencies to serve a variety of purposes including:

- Assessment of habitat change due to natural or human impacts (e.g. climate change, oil spills, trawl disturbance)
- Monitoring and protecting important habitats (e.g. marine reserves, spawning areas, harvest closure areas)
- Design and location of marine reserves or aquaculture projects
- Species distributions and stock assessment

While most subtidal species and resources can only be sampled directly using observational or other large scale (>1:10,000) survey techniques, it would be impractical to apply this level of effort to the entire coast of California. A major goal of habitat mapping, therefore, is to develop the ability to predict the distribution and abundance of species and resources from those physical and biotic parameters that can be remotely sampled.

Habitat parameters important to the distribution and abundance of benthic and nearshore species include but are not limited to: water depth, substrate type, rugosity, slope/aspect, voids (abundance, type and size), sediment type and depth, exposure, vegetation, chemistry, temperature, presence of other species.

Because the response of different species often varies with the spatial extent of these parameters, habitat scale is another factor important in defining where different species and biotic communities are likely to be found. For this reason, a benthic habitat classification system useful for defining species/habitat associations based on the parameters listed above must also be hierarchically organized according to relevant spatial scales.

Given these considerations, a regional habitat mapping program should include the following elements:

- Clear statement of purpose for the mapping project (e.g. well defined goals and objectives).
- Selections of scales for map extents and data resolution appropriate to the stated purpose.
- A universally accepted and broadly applicable hierarchical habitat classification system based on spatially nested physical and biophysical characteristics that control where species live.
- A means for acquiring data at appropriate resolutions and spatial scales for each of the relevant habitat characteristics.
- A means for combining, analyzing and displaying geospatial data sets collected in diverse formats, and at different scales and resolutions such that the habitat classification system can be applied.

1.5. GENERAL FINDINGS

There are now keen interests, new legislative mandates, and compelling needs driving many state and federal management agencies in the direction of nearshore habitat mapping. Most agencies, however, lack the expertise, equipment, and financial ability to collect, process, analyze, and use the types of habitat data required by these new mandates. Those that do or did, such as the US Geological Survey, have been faced with the loss of experienced personnel through downsizing, and the fiscal inability to keep up with the rapidly changing and very expensive technologies required. While there are numerous private companies that do have these capabilities, much of their mapping work has been done for private interests (e.g. telecommunications companies) that are either not permitted or willing to share their data with public agencies due to a highly competitive market place. Military data, though potentially abundant regionally, is primarily in hard copy form, poorly georeferenced, and difficult to locate and access without help and interest from within the military.

As a result of these factors, several agencies including the Department of Fish and Game are exploring the avenues open to them for acquiring and utilizing marine habitat data. To date, however, there has been little coordination to leverage these efforts among the interested agencies. Further confounding matters is the lack of a generally accepted habitat classification system appropriate for nearshore marine environments. This lack of coordination means that efforts will be duplicated, and that data sharing will be hampered by lack of uniformity in data collection, classification and processing protocols. Given that marine biotic habitat mapping is still in its infancy, however, there remains an opportunity to coordinate and leverage resources in the development of these habitat maps, technologies and protocols.

The established methods and acoustic mapping technologies in current use are capable of creating highly detailed maps of 3D seafloor morphology and substrate type at sub-meter resolutions over broad areas of habitat. Much of the biotically important detail in habitats,

however, can occur at the level of decimeters and centimeters. As a result, direct sampling and video imagery are often necessary to augment the detail provided via acoustic remote sensing. While the combination of these methods is capable of yielding highly detailed results, the expense involved can be impractical due to the relatively slow data acquisition rates compared to that required for remote sensing in terrestrial habitats. Obtaining a high resolution, groundtruthed image of a square kilometer of seafloor can take more than a day to acquire at great expense, compared to just minutes needed to obtain relatively inexpensive aerial photographic coverage of terrestrial habitat. Given the extensive coastline of California and the fact that it is often impossible to conduct conventional boat-based acoustic surveys in the 0-10m depth range due to geohazards, new more efficient mapping technologies need to be developed. Emerging laser and digital video mapping techniques such as LIDAR, Laser linescan and CASI, may enable aircraft to routinely sample the bathymetry and substrate in intertidal and shallow subtidal habitats that are inaccessible or too costly for conventional acoustic survey methods.

Regardless of which type of high resolution, broad coverage seafloor mapping techniques are selected, the cost of the equipment and expertise required to effectively operate and maintain it will generally be outside the budget of most resource management agencies. As a result, most agencies will find it cost effective to contract out for the actual acquisition of seafloor survey data, while developing the more generically useful GIS capabilities in-house that are required for the synthesis, analysis, display and application of these data.

1.6. RECOMMENDATIONS

Based on these findings we make the following recommendations to the Department regarding the development of habitat maps for the California nearshore environment.

1. Identify, collect, evaluate and convert all existing seafloor substrate and bathymetry data to digital GIS format for habitat classification. Special emphasis should be given to the 1986 Geology Maps of the California Continental Margin compiled by the USGS and California Department of Conservation Mines and Geology.
2. Convene a strategic planning workshop involving all parties having a vested interest in mapping California continental shelf habitats to:
    - Identify opportunities for leveraging resources, combining missions and sharing data
    - Define and adopt a universally applicable habitat classification scheme
    - Develop criteria and standards for prioritizing sites to be mapped
    - Develop criteria and standards for selecting mapping methods, scale and resolution
    - Develop a prioritized list of sites to be mapped
    - Draft a mission statement and strategic plan for funding
3. Create an initial set of “baseline” habitat maps for the continental shelf by applying the adopted classification scheme to existing seafloor habitat data in GIS format. The 1986 Geology Maps of the California Margin offer an ideal starting point.

4. Ground truth these baseline maps for accuracy and value.
5. Pursue in-house and multi-agency funding and support to carry out a strategic plan for mapping the habitats of the California continental shelf over the next decade
6. Develop partnerships with universities and other resource agencies as cost effective means for acquiring new data and developing new methods for data analysis and display.
7. Evaluate new technologies for more efficient and higher resolution habitat mapping in shallow nearshore environments. Testing these new techniques at sites where conventionally acquired data is already available or acquired simultaneously would be a logical first step in the assessment process.
8. Build up expertise and infrastructure for GIS analysis within the DFG marine group to make use of newly acquired and reprocessed geospatial habitat data.
9. Use GIS to combine geophysical habitat data (depth, slope, aspect & substrate) with new and existing species distribution and fishery data to test and refine the habitat classification scheme.
10. Explore links with NOAA and the military to reprocess existing data as well as collect new habitat data needed to complete the strategic plan.