Seafloor Mapping Lab - California State University Monterey Bay
Supporting Marine Stewardship Through Science, Technology, and Education

The Seafloor Mapping Lab (SFML), within the Division of Science and Environmental Policy at California State University Monterey Bay, specializes in high-resolution acoustic remote sensing for coastal habitats. Combining research and education with state-of-the-art geospatial technology, the SFML offers unique hands-on, field-to-finish experience to students while conducting professional habitat mapping surveys for resource management and basic research along the continental margins. The successful execution of this mission has made SFML an effective collaborator with a variety of resource agencies and applied research consortiums including: CICORE, CeNCOOS, CDFG, USGS, USACE, and the California Coastal Conservancy. Data from these collaborations have been used to monitor coastal erosion, assess tsunami potential, identify essential fisheries habitat, design and manage marine protected areas, develop tools for the sustainable management of California's squid and rockfish fisheries, facilitate ecosystem-based management within the Elkhorn Slough National Estuarine Research Reserve and Morro Bay, and maintain shipping channels and facilitate beach replenishment at the mouth of San Francisco Bay. http://seafloor.csumb.edu

R/V VenTresca
A custom built, shallow draft, 35 ft. aluminum hydrographic survey catamaran- with the same **state-of-the-art** sonar mapping and ROV technology found on large hydrographic research vessels, but here in a tow-able configuration designed for near shore shallow water habitat work. Detailed vessels specs can be found at http://seafloor.csumb.edu/Ventrescaspecs.html

Profile History

The Earth System Science and Policy Program at CSUMB created the Seafloor Mapping Lab (SFML) to provide students with more advanced classes and training in cutting-edge geospatial technology. The goal of the SFML has been to pursue student-centered research grants and contracts needed to acquire and maintain its state-of-the-art integrated seafloor mapping system including sonar (multibeam, sidescan, and sub-bottom profiler) and ROV technologies for undergraduate research and education. A graduate-level program was offered in the Fall of 2006. The SFML system has now logged over 200 days of survey and teaching time, been awarded more than $3 million in research grants and contracts, and provided 50 SFML students with the opportunity to learn and apply their skills in mapping 150 miles of west coast nearshore habitats for state and federal resource management agencies.

High-resolution bathymetry and seafloor habitat maps are becoming the standard requisite for nearly every coastal marine management program at the state and federal level. As a society, our ability to understand and manage ecosystems is increasingly dependent upon mastery of advanced technologies for acquiring, analyzing and visualizing geospatial information pertaining to the physical, biological and societal properties of these systems. The high quality marine habitat and baseline data products from such efforts are increasingly relevant and valuable to science and to the resource managers that must apply the information to current research initiatives and critical environmental issues.

Data Acquisition

SFML Director Rikk Kvitek deploying Reson 8101 mulibeam sonar head.

Multibeam Sonar Seafloor Mapping System
The SFML maintains and operates a complete multibeam bathymetry mapping system. A hull-mounted 240 KHz Reson 8101 SeaBat multibeam system with sidescan sonar option is used in conjunction with a Triton Imaging Inc. Isis System for data logging and sonar control, along with Delphmap and BathyPro software for real-time sidescan mosaicking and DEM generation. Vessel motion correction is performed using an Applanix POS/MV (position accuracy ± 2m, pitch, roll and heading accuracy ±0.02°, heave accuracy ±5% or 5cm). Survey planning and navigation is done with Hypack Max from Coastal Oceanographics and a Trimble Navigation 4700 GPS with Navbeacon and internal radio for DGPS and RTK horizontal positioning. A Trimble 4700 reference station with TrimMarkIIe UHF radio is used for DGPS or RTK when necessary, especially in tidally complex settings. CNAV data are used to account for tide cycle fluctuations and sound velocity profiles collected with an Applied Microsystems SVPlus sound velocimeter.

Sidescan Sonar Seafloor Mapping System
The SFML also operates a traditional towed EdgeTech 260TH dual-frequency (100 & 500 KHz) system. The EdgeTech sonar can generate very high resolution (10-20 cm) imagery throughout the continental shelf depth range (1-300 m), while the Reson performs best in depths < 150 m. Data from both systems are displayed and recorded using a Triton Imaging Inc. Isis Sonar data acquisition system with real-time mosaic generation.

ROV Video Mapping System
The SFML Hyball ROV system is used to acquire underwater video imagery for use in habitat identification, groundtruthing, and quantitative biological data collection. The Hyball has a 300 m depth capability and is fitted with four thrusters. The internally mounted video camera can tilt and view through 360 degrees. Imagery is recorded on a JVC BR-DV600 mini-DV digital VCR. Two parallel 10mW lasers (10 cm separation) track with the camera, providing a scale reference in the recorded imagery.

Sub-bottom Profiling Sonar System
The SFML operates an EdgeTech SB-424 Full-Spectrum sub-bottom chirp profiler for determination of seafloor sediment and rock layer thickness. The SB-424 has a frequency range of 4-24 KHz, with ±4 cm vertical resolution.

"THANK YOU for providing the data that is there, WITH metadata to make it useful!!!" - testimonial 2

Staff-student workforce in action (clockwise from top): deploying the Hyball ROV, configuring a GPS base station at a remote site, processing multibeam bathymetry survey data.

"The data available on your Seafloor Mapping Lab Internet site has been a valuable resource." -testimonial 1
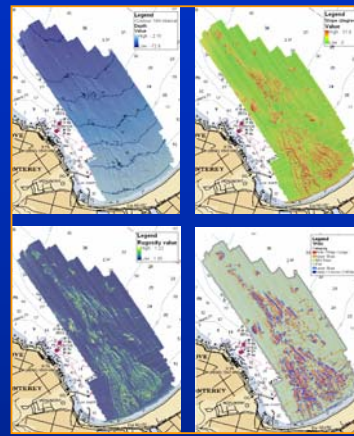
Processing

Multibeam bathymetry data are post-processed using Caris HIPS and SIPS hydrographic software. Soundings are filtered and corrected for vessel motion using Applanix POS/MV data, SVP data, and adjusted for variations in water height (tides) using vertical position data from a NavCom 2050 GPS receiver (CNAV). Cleaning of false data points or "noise" is completed in Caris HIPS and SIPS software. Geotiffs are exported from Caris Spatial Editor with a 1-3 m spatial resolution. All x,y,z files, DEMs, shaded relief images, and other derived products are generated in the Universal Transverse Mercator (UTM) coordinate system, zone specific, WGS 1984 datum.
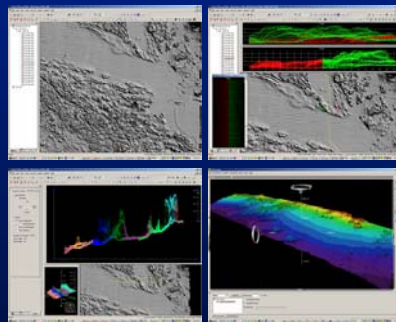
Caris HIPS and SIPS hydrographic software: Cleaning Process. Fledermaus 3D visualization software: Quality Control.

Ground-truthing of the real-time sidescan sonar mosaic is done with a Petite PONAR sediment grab fitted with a SplashCam video drop camera. Sediment grain size analysis (40 μ – 2 cm) is done with a Micromeritics Optisizer 5400 PSDA, and video data is recorded on a JVC mini-DV digital video tape deck equipped with a Horita GPS-3 interface for stamping each frame with time and GPS position. Triton Imaging Inc. Isis Sonar is used for post-processing the original sidescan sonar. Final xyz bathymetry grids for ArcGIS derivative products are created in Fledermaus by IVS.

"Thank you again for making such high-resolution data easily available. Hope you tell along to any of the sponsors, grad students, techs, or others who worked to make this possible. You guys rock!" - testimonial 3

Analysis of ROV survey data relative to four factors: Depth, Slope, Rugosity and Topographic Positioning Index (TPI)

Derived Products

The SFML generates a standard suite of final multibeam bathymetry products for each mapping project- including the generation of surface models from xyz files, ArcGIS grid creation, surface analysis, creation of contour lines, assembly of basemap layers such as coastline polygons & NOAA charts, using a standard naming convention. Other products are provided on a project-specific basis (e.g. raw XTF, ground-truth sampling data). SFML final data products include FGDC-compliant metadata.

GIS Analysis and Image Processing
The ability and need to accurately combine and visualize high resolution environmental data at regional and global scales have driven the rapid co-evolution of remote sensing, geographic information systems (GIS), and satellite global positioning (GPS) instrumentation for use in both terrestrial and marine environments. The SFML utilizes advanced integrated GIS technologies in developing GIS-based species/habitat databases and spatial data models. Final products can include high resolution 3D digital terrain models draped with habitat raster imagery of nearshore marine environments for use in efficient, sustainable, and environmentally sound management of significant marine resources.

Data Library

Database Development and Web Delivery of GIS Mapping Products
Distribution of SFML mapping data is via a web portal system. Derived products are catalogued by survey location and data type. Raw XFT or cleaned HDCS format data are made available on special request. http://seafloor.csumb.edu/SFMLwebDATA.html

SFML mapping data products are publicly available through the Center for Integrated Coastal Observation, Research and Education (CICORE) program funds. This funding support allows continued development and data population of our ArcIMS geodatabase and HTTP data delivery (**SFML Data Library**) servers for dissemination of all multibeam, sidescan sonar data and derived GIS products. Access to the CSUMB-CICORE data can be found at: http://seafloor.csumb.edu/CICOREweb.html. Public interest in these mapping data sets has included a widespread and varied audience.
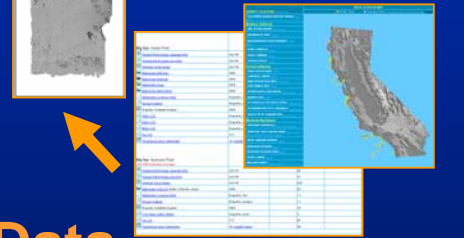
As part of our efforts for data sharing, product development, and integration with other programs, CSUMB/SFML has been working with other technical groups (e.g. MLPA Initiative Decision Support Team**)** to evaluate the continued development and performance of the CSUMB-CICORE data support systems (IMS server and HTTP Data Library, including potential expansion to ArcGIS Server and Google Earth viewer tools) for serving SFML acoustic remote sensing data products. These ad-hoc collaborations benefit from the technical expertise of the members by reviewing, designing and implementing analogous data systems (architecture) and tools at various institutions to provide a uniform data sharing structure. In addition to evaluating the physical performance of the CSUMB data servers, web-user access and data downloads are being monitored by SFML via web-tracking software in order to analyze website traffic on the SFML Data Library.