

Center for Integrative Coastal Observation, Research and Education

[http:// www.mlml.calstate.edu/cicore](http://www.mlml.calstate.edu/cicore)

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The California State University Center for Integrative Coastal Observation, Research and Education (CI-CORE)

I. Introduction

The California State University (CSU) led California Center for Integrative Coastal Observation, Research and Education (CI-CORE), an applied coastal research center, completed its initial year of operations 31 July 2003. CI-CORE (<http://www.mlml.calstate.edu/cicore>) is dedicated to producing nationally relevant solutions to the many challenges facing our marine and estuarine environments through the creation of a coastal observatory to address such economically and environmentally important challenges as coastal erosion, watershed impacts, chemical contamination of food webs, depletion of fish stocks, toxic plankton blooms, marine-borne pathogens, and the rapid invasion of coastal and estuarine waters by non-indigenous species. The CI-CORE program's primary goals are to provide (i) timely and appropriate environmental data and analyses to scientists, agencies and the public for policy development and the evaluation of the effectiveness of coastal and environmental policy and (ii) near real-time publicly accessible web-based products developed from the observatory sensors.

The CI-CORE year-two proposal was written with the expectation of either level (\$1.75 million) or expanded support (up to \$3 million). Instead the program suffered a funding reduction to less than \$1 million. The funding reduction occurred after the program proposal was submitted. The program has been forced to scale back and postpone many objectives. Despite this funding shortfall, the CI-CORE program continues to be a vibrant contributing participant in the emerging implementation of the Ocean.US IOOS vision.

II. Year-Two Objectives

The major objectives in the year-two proposal, listed by institution:

Moss Landing Marine Laboratories (MLML)

- 1) Continue to provide program coordination.
- 2) Develop and deploy a buoy-mounted sensor package in Elkhorn Slough
- 3) Lead the ground truthing effort for the hyperspectral overflights
- 4) Work with FERI to provide the following:
 - a. Maps of bathymetry for selected optically shallow waters
 - b. Maps of bottom characterization for selected scenes
 - c. Maps of kelp cover for all images containing surface canopies

Florida Environmental Research Institute (FERI)

- 1) A description of operating conditions required to achieve high spatial resolution HyperSpectral Imagery (HIS) in the nearshore region.
- 2) Copies of all CI-CORE calibrated and geo-rectified hyperspectral imagery for archival at Cal Poly SLO.

- 3) Research and develop the procedures necessary to atmospherically-correct HIS data.
- 4) Resampling of sensitive areas to determine time dependent change of macro- and micro-algae in the near shore environment
- 5) Expanding the area of hyperspectral coverage both north (San Francisco Bay) and south (Santa Barbara Channel)
- 6) Completion of algorithm for Harmful Algal Blooms (HABs) and macro-algae, and their speciation
- 7) Increased accuracy of geo-spatial rectification
- 8) Decreased turn-around time for data and derived products
- 9) Completion of a web-based delivery system of data and products

California Polytechnic State University, San Luis Obispo (Cal Ploy SLO)

- 1) continue to develop the framework to monitor temporal and spatial changes in the region's watersheds, estuarine and coastal habitats.
- 2) Support validation of hyperspectral overflights with measurements taken both in situ and above water in the area of coverage
- 3) Duplicate the validation instrument suite assembled by MLML

California State University Monterey Bay (CSUMB)

- 1) CSUMB's Sea Floor Mapping Laboratory (SFML) will collect multibeam bathymetry and sidescan sonar benthic characterization data for validation of the hyperspectral data
- 2) Development of web-based data dissemination
- 3) Sampling will be done in regions not yet sampled
- 4) Repeat sampling will be done at selected sites for documenting bottom change
- 5) Continued production of marine habitat maps for several regions

San Francisco State University (SFSU)

- 1) The Romberg Tiburon Center (RTC) will continue development of the prototype in situ sampling package by adding new optical instruments
- 2) Continue development of the internet-based approach for delivering data and products in near real time
- 3) Extended spatial coverage of San Francisco Bay by establishing routine shipboard surveys
- 4) Collaborate with other CI-CORE partners in support of validation measurements for the hyperspectral data.

Humboldt State University (Humboldt)

- (1) Expansion of water quality measurements in Humboldt Bay.
- (2) An assessment of the spatial and temporal variation of eelgrass biomass and shoot densities in Humboldt Bay, to support habitat monitoring for local resource managers.
- (3) An assessment of seagrass and invertebrate populations at rocky intertidal sites within Humboldt Bay (an extension of the initial monitoring program of habitat recovery since the November 1997 MV Kure oil spill).

- (4) Monthly monitoring of subtidal "fouling" communities at Woodley Island, Humboldt Bay (environmental influences; assessment of invasive/exotic species).
- (5) Nutrient dynamics in Humboldt Bay.
- (6) A study of intertidal communities, including juvenile rockfish, in the rocky intertidal zone near Trinidad Bay.
- (7) Marine mammal surveys (including sea lions, seals, gray whales and dolphins) along the coastal northern California.

California State University Hayward (Hayward)

- 1) Deploy and maintain two continuously-recording optical backscatter sensors (OBS) in San Francisco Bay.
- 2) Monitor turbidity and estimate total suspended solids (TSS) in San Francisco Bay and Delta.

III. Program Performance

Moss Landing Marine Laboratories (MLML)

Coordination Activities concentrated on the programmatic details of developing a distributed coastal observatory. The work includes internal communication among members, planning for the expansion of the program to CSU campuses in Southern California, regional coordination with other COTS programs and organizational participation at the national level to promote implementation of the emerging vision for the Integrated Ocean Observing Systems as articulated by Ocean.US.

Specific headquarters activities included:

- 1) The successful transition of the CI-CORE program coordinator from Dick Zimmerman to Toby Garfield. Dr. Zimmerman left MLML for a position at Old Dominion University. Dr Garfield, a CI-CORE PI from SFSU, assumed the position as part of his visiting faculty position at MLML.
- 2) A CI-CORE PI meeting was held in December, 2003 to plan year-three activities and to evaluate proposals from Southern California CSU campuses for expansion of CI-CORE. Subject to funding, CSU Long Beach and San Diego State University were asked to participate starting with year-three funding (8/04–7/05).
- 3) Outreach Activities:
 - a. Co-hosted, with the COTS Alliance for Ocean Technology (COTS), a marine metadata workshop which provided important progress toward establishing FGDC-compliant metadata protocols for CI-CORE and other COTS programs.
 - b. Co-hosted a public seminar by CI-CORE PI Rikk Kvittek where he presented a community lecture results from his work with high resolution multibeam bathymetry.
 - c. Participated in the U.S. Congress's Oceans Week by providing a Congressional briefing at the request of Congressman Sam Farr.
 - d. Participated in a joint NOAA/ONR Coastal Ocean Observatory Interoperability forum

- e. Organized a MLML/FERI/ODU working meeting to establish the protocols for obtaining and processing ground truth data in support of hyperspectral overflights.
 - f. Continued meeting with NOAA Monterey Bay National Marine Sanctuary's Sanctuary Integrated Monitoring Network (SIMoN) to resolve coordination of hyperspectral flights. This included meeting with the SIMoN Research Advisory Panel (RAP).
- 4) In order to better unify the CI-CORE web presence, Dr. Dale Robinson, SFSU CI-CORE member, has agreed to review the member websites and plan for modifications to enhance our content delivery. Dr. Robinson is working with other regional observatories (CIMT, CenCOOS) and his position will help with the unification of efforts into a strong regional association.
- 5) Regional Association Development
- a. Participated in the Central California Coastal Ocean Observing System (CenCOOS) search for a program coordinator. The CI-CORE coordinator is a member of the CenCOOS temporary Executive Committee which will act as an advisory committee to the CenCOOS coordinator until a formal governance structure has been implemented.
 - b. CI-CORE is coordinating with Center for Integrated Marine Technology (CIMT) to mount the ground truth field program during the March hyperspectral overflight campaign.

MLML field activities

- 1) The main field activity is the continued development of a prototype environmental buoy for deployment in Elkhorn Slough. Data will be broadcast via radio link in near real time. At present, all the hardware components have been assembled and deployment awaits resolving software issues.
- 2) The program is consolidating multiple environmental monitoring at the lab into a single location, accessible through the MLML CI-CORE web site.
 - a. Water quality measurements from the small boat facility.
 - b. Water quality measurements from the sea water system intake pipe.
 - c. Meteorology measurements from a sensor suite at the main laboratory building.

Planned Activities still to be accomplished:

While most of the year-two activities are well on the way to successful completion, it became necessary to reduce the number of hyperspectral campaigns from the planned two to a single campaign. The funding shortfall is severe enough that the program considered canceling both planned collects. However, it was agreed that it is important to develop a time series of hyperspectral imagery. Monies are being directed to the collection of data, processing will be postponed until next fiscal year. The planned October set of flights was cancelled in favor of a March set of flights. The main reason for choosing March is that the flights last April only covered Monterey Bay. Both inclement weather and a NOAA directed stand-down of the airplane prohibited sampling the intended region.

Florida Environmental Research Institute (FERI)

FERI personnel have made significant progress toward enabling the use of hyperspectral imagery as a standard monitoring tool. Accomplishments up to now include

- 1) Improved geolocation of the imagery obtained from deploying a dedicated differential GPS system during the flights.
- 2) A description of operating methodology for obtaining high spatial resolution imagery with the HSI system.
- 3) Posting of the calibrated hyperspectral data on both the FERI and Cal Poly SLO web sites.
- 4) Sample atmospherically corrected data for San Luis Bay from the October 2002 data.
- 5) Sample data products from San Luis Bay which include:
 - a. Water quality and the presence of a phytoplankton bloom
 - b. Kelp bed identification
 - c. Nearshore bathymetry
 - d. Nearshore bottom characteristics
- 6) Distribution of data and products in different formats
- 7) A data report to the SIMoN program describing the prototype products

During this period, FERI has concentrated effort on developing a web-based delivery system for both data and derived products. This has evolved into two delivery systems, one for the hyperspectral data, and one for the products. Data delivery is through submission of a request for data for a specific location. Upon acceptance of the request, all the requested data are located and deposited on a protected ftp site for ftp transfer.

Data products are made available through ESRI ArcIMS implementation which allows users to view all products as GIS data layers. The layers can be transferred as view-only layers into an ArcGIS project on the viewer's computer. Once the user has identified the content needed from the GIS layers, the data can be requested for ftp transfer.

Planned Activities still to be accomplished:

Using the data from San Luis Bay, concerted effort has been devoted to developing the necessary protocols to use the ground truth data to derive the atmospheric correction needed for each scene. This has led to significant advances in the ability to atmospherically correct HIS data on a routine basis; however further work has been hampered by the redirection of limited resources toward the collection campaign.

California Polytechnic State University, San Luis Obispo (Cal Poly SLO)

Cal Poly has been able to continue the development of its pier-mounted water quality monitoring facility. Components were purchased in year one, and year two has seen the installation of the system. A series of five sensors provides water quality measurements over the depth of the water column at the pier end.

Cal Poly is contributing to the collection of ground truth data for the hyperspectral imagery but obtaining a special set of panels for radiometric calibration of the aircraft sensor. These panels will be spread on the ground, over a dark target area, as a target for the PHILLS sensor. The radiometric properties of the panels are designed to assist in the development of the atmospheric correction. During the March collect, the panels will be moved daily so that the aircraft will observe the panels in close proximity to the sampling area.

Planned Activities still to be accomplished:

Cal Poly will obtain a set of instruments to duplicate the instruments at MLML for ground truth operations during the hyperspectral overflights. Purchase of these instruments will be delayed, again due to the funding cutback.

California State University, Monterey Bay (CSUMB)

CSUMB has devoted its year-two effort into the development of web-based data dissemination tools. This has led to the implementation of three different approaches for data access. Like the hyperspectral data, multibeam bathymetric data sets are very large. Recovery of the multibeam data is via an http download site.

Products are displayed using an ESRI ARCIMS server. Similar to the hyperspectral products, the user can view and recover as view-only layers the products which have been posted in the GIS server. Recovery of the data is via the http server.

CSUMB has also implemented an Oracle SDE spatial database server. At this point, this data access and distribution tool is still in beta testing.

The shortage of funds this year has prevented CI-CORE specific multibeam data collects. However, other funds have allowed CSUMB to continue data collection in the CI-CORE region. A very important aspect is the ability to revisit sites. The high resolution multibeam data are a powerful tool for looking at bottom characteristic changes. A revisit of the head of Monterey Submarine Canyon documents the deposition of dredge spoils from Moss Landing Harbor, and slumping erosion at the canyon head and sides.

Planned Activities still to be accomplished:

Comparison and validation of the hyperspectral-derived bathymetry and bottom type characterization has been postponed until the hyperspectral products for regions where multibeam bathymetry data are coincident.

San Francisco State University (SFSU)

SFSU has continued the development of the in situ sampling package by adding a number of sensors for water quality measurements. In addition to the CTD package with PAR, and a transmissometer, a Turner Designs SCUFA (Self Contained Underwater

Fluorescence Apparatus) measures in vivo fluorescence as a measure of phytoplankton chlorophyll. Additional instruments are in prototype deployment; an Envirotech four-channel nutrient sensor obtains nitrate, silicate, phosphate and ammonium concentrations at intervals of two hours. A CytoSense flow cytometer measures the number and forward and side-scatter of phytoplankton-sized (2-200 μ m) particles along with their fluorescence characteristics. The software is being modified to handle the large inorganic suspended load found in San Francisco Bay.

Two other instruments are being prepared for prototype deployment. A horizontal ADCP will measure the shear of the horizontal flow out into the main channel in front of RTC. A Laser Optical Particle Counter (LOPC) will count and image zooplankton sized particles.

Weekly net and water samples are being collected and analyzed to calibrate all of these instruments.

The SFSU CI-CORE web site continues to expand. Near real-time water quality data are available with a delay of less than 30 minutes. Data for the prototype instruments are added as processing these data allow.

Planned Activities still to be accomplished:

Expansion of the spatial resolution by the initiation of shipboard surveys has been postponed due to the budget reduction. In addition, new instruments to expand the observatory have also been postponed pending year three funding.

Humboldt State University (Humboldt)

Humboldt has concentrated its efforts on measurements and observations in Humboldt Bay. The initial CTD data logger in the Bay is deployed and the data are retrieved and uploaded to the web roughly every month.

Monthly fish sampling at the eelgrass beds near the mouth of Humboldt Bay has continued in Year 2. Fish samples are identified, enumerated and measured to the nearest millimeter to assess the health of the resource. Data from the 3,555 samples, representing 36 species, have been provided to the local California Department of Fish and Game and California Sea Grant. These data will also be posted to the web in the near future.

Along the coast, CTD profiles were measured at Trinidad Pier on a roughly monthly basis. The variability observed at the pier indicates it is a good site to monitor coastal water quality variability, including the influence of runoff from the nearby Mad and Little Rivers.

The Humboldt CI-CORE web site is operational and development of web-accessible data management has begun.

Planned Activities still to be accomplished:

Expansion of the in situ monitoring of water quality and conversion to near-real-time data acquisition has been postponed due to the funding reduction. Purchase of new equipment to expand monitoring in the Bay and at Trinidad Head await the restoration of funds in Year Three. In addition, a number of other assessments of the coastal environment in the region have not been undertaken due to a shortage of funds.

California State University, Hayward (Hayward)

This marks the initial CI-CORE effort by Hayward. Computer hardware and software were deployed and configured for data management and analysis. Field equipment was refurbished and a new sampling program was undertaken. Spatial and temporal variations in sediment size distribution and total mercury concentration in San Francisco Bay and Delta were studied based on both historical data and new sediment samples. All sample data have been compiled in ArcGIS format.

Planned Activities still to be accomplished:

Additional sediment samples will be collected from sites in the San Francisco Bay Delta and analyzed for particle size distribution and trace element chemistry. Data will be compiled in ArcGIS and FGDC-compliant formats and made available through a web-based interface.

Hayward will assist with in-situ measurements of water properties during the March hyperspectral collection efforts in San Francisco Bay.

Hayward originally planned to deploy Optical Backscatter Sensors (OBS) in two locations to monitor turbidity and estimate total suspended solids (TSS) in the Bay and Delta. Plans to obtain these instruments have been postponed due to the budget reduction and will be implemented with year-three funding.

IV. Summary

During the first half of the second year of the program, CI-CORE personnel have continued to concentrate on the first long-term objective of the program: establishment of research and monitoring infrastructure of critical coastal habitats in California for integration into global ocean monitoring efforts. In addition, through the development of the web sites at the member institutions, the program is providing public access and awareness of the importance of coastal management.

Despite the severe budget reduction of this second year, the program has continued strong development toward being a critical element of coastal monitoring along the California coast. This was accomplished by reducing planned expansion of both members and individual capabilities to concentrate instead on the implementation of efforts initiated during year one. This enables each participating campus to support most of the personnel

devoted to the project and continue development of products from equipment already deployed.

Some of the success can be measured by the development of the web presence at each member institution, and the content offered at each site. Over the next few months, the appearance of these sites will evolve as we put a more uniform appearance on this distributed ocean observatory.

CI-CORE web pages at the member institutions:

Moss Landing Marine Laboratories	http://www.mlml.calstate.edu/cicore
California Polytechnic State University, San Luis Obispo	http://www.marine.calpoly.edu/cicore/default.shtml
California State University, Hayward	http://www.sci.csu Hayward.edu/cicore/
California State University, Monterey Bay	http://seafloor.csumb.edu/CICOREweb.html http://seafloor.csumb.edu/arcims.htm
Humboldt State University	http://cicore.humboldt.edu/
San Francisco State University	http://sfbeams.sfsu.edu
Florida Environmental Research Institute	http://www.flenvironmental.org/ http://feriims.flenvironmental.org