**Concept Paper**

# California Center for Integrative Coastal Research

# (California CI-CORE)

A Proposed CSU Marine Science Initiative

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## Overview

California State University (CSU) proposes to establish a regional applied coastal research center dedicated to developing nationally relevant solutions to challenges facing our marine and estuarine environments. This regional center will focus on the central and northern coastal regions of California, and will serve as a national model for demonstrating how dramatic advances in marine instrumentation, computer modeling, 3D visualization and the internet can be harnessed to give more people greater accesses than ever before to easily interpretable environmental information of critical importance to the sustainable management of our marine and coastal resources.

The lead CSU campuses will be San José State University (Moss Landing Maine Laboratory), CSU Monterey Bay (Monterey Bay and Elkhorn Slough), San Francisco State University (Romberg Tiburon Center), CSU Hayward (San Francisco Bay/Delta) and Cal Poly San Luis Obispo (Central California Coast). By building on programs and expertise already existing in these respective institutions, CI-CORE will tackle such economically important challenges as chemical contamination of food webs, depletion of fish stocks, the spread of toxic plankton blooms, and the rapid invasion of coastal and estuarine waters by alien (non-indigenous) plant and animal species from Asia and elsewhere. CI-CORE will provide timely, indispensable and appropriate environmental data to regulatory agencies that are responsible for the development and enforcement of management policies. Uniquely, CI-CORE will provide these data through the development of web-based, geo-referenced time series of environment changes to scientists, policy makers and the general public to determine if implemented polices are meeting their intended goals. Such data will be invaluable in assessing the long-term effects of "natural" (e.g., El Nino and La Nina) and "unnatural" (e.g. human induced habitat destruction, pollution, and pathogens) perturbations on marine and estuarine environments.

## The Need

The national Oceans Conference held in 1999 in Monterey, CA focused the Nation's attention on the value of marine resources. Seventy percent of the US economy is dependent upon these resources through commerce, oil production, shipping, direct exploitation (fishing and mariculture), sewage, agricultural and industrial waste disposal, and recreation. Over 50% of the total biological production of the oceans and more than 99% of the world's catch of marine fish occur in coastal waters. These near shore environments are becoming more and more impacted and therefore threatened as a result of urban development and agriculture. Of the 32 million people living in California, the great majority live along its coastline and this majority is ever increasing both here and worldwide. The problems facing coastal resources here in California, will be problems elsewhere if they are not already. The solutions found to these problems can be exported around the globe.

Multiple use of coastal space, the dependency of society on coastal processes and resources, and the fragility of the marine environment all require that rational, integrated and sustainable management strategies be developed. Traditional coastal management has

predominantly been through reactive, localized efforts designed *ad hoc* to protect specific resources. It is only recently that a rise in public awareness has initiated a new approach to marine and coastal resource management, one based on longer-term planning, and a more regional understanding of the link between ecosystem processes and economically important resources. While this concept, frequently referred to as Coastal Zone Management (CZM) is widely recognized as the ideal, the new technological tools and methodologies required to achieve these goals are still underdeveloped. It is clear, however, that for effective management of the coastal zone, policies must be based on informed decisions. This ability, in turn requires ready access to appropriate, reliable and timely environmental information and data, in suitable form for the task at hand. To meet this need, we urge the creation of a new regional research center devoted to the development, integration and application of these new technologies for the acquisition, analysis, visualization and dissemination of information for effective coastal zone policy and management solutions.

The north and central coast of California offer an ideal location for this regional center. One of the richest areas of marine resources in California and in the world, this region extends from Point Conception to Eureka, a coastline equal in distance to that from Maine to Washington DC. The coastal issues of this region are typical of those facing our nation. Resource agencies here are struggling to balance the management of one of the most important fishing grounds and marine mammal sanctuaries of the United States, with rapid urbanization, thriving agriculture and booming marine-based tourism. For example, the San Francisco Bay today has this country's only active commercial fishery grounds surrounded by a major urban area, where the herring fishery provides important economic and social benefits. Unfortunately this region is also one of the most understudied in the United States. For instance, whereas the northeastern region of the United States has major marine research centers such as the Woods Hole Oceanographic Institution, there is no such center focused on the central region of California. Within California, the Scripps Institution of Oceanography in San Diego focuses on marine habitats south of Point Conception, which have distinctly different physical (e.g., currents) and biological (e.g., fisheries) characteristics than the central California coast. Thus there is a pressing need to establish a regional center of applied marine research that can meet the environmental challenges posed by the growing population and rapidly expanding economy of central California. A new center, which as describe above, would serve as a national model for how a regional university cooperative can provide public dissemination of relevant coastal environmental data.

## Plan To Meet The Need

***Goals and objectives*.** Our goal is to develop an integrated, applied research center (**California Center for Integrative Coastal Research - CI-CORE)** whose focus is the coastal and estuarine marine environments of the northern California region. Scientists associated with CI-CORE will address research questions that have direct applicability to the economy, environment, and people of northern and central California. The center will study the marine and estuarine systems, conduct applied experiments, advise policy makers, and share its data and discoveries with federal, state, and county agencies. It will not be a center that is isolated from the public, but rather an interactive research center that readily promotes the engagement of the general public as well as K-12 teachers and their students in the research efforts and data collected by the center's scientists.

**CI-CORE** 's specific objectives will be to:

1. Establish a regional coastal research and monitoring infrastructure for ultimate integration into a global oceans monitoring system as called for by national legislators, and a host of agencies such as the Consortium for Oceanographic Research and Education, the National Oceanographic Partnership Program, and national agencies involved in conducting ocean sciences research.
2. Conduct research on topics that have a direct effect on the economy and marine and estuarine environment of people living in northern California (e.g., geochemical and biological processes controlling contaminants in the food chain; declining fisheries, toxic plankton blooms, invasion of such species as mitten crab and Asian clam on pipelines, waterways and endemic species.)
3. Provide the environmental time series of scientific record upon which other research can be interpreted.
4. Construct an integrated and geo-referenced basemap and database of environmental conditions and changes throughout the region's watershed, estuarine and coastal habitats.
5. Develop mechanistic models that will enable scientists to evaluate the significance of observed changes.
6. Enhance the ability of regulatory agencies to promote, adopt and quantitatively evaluate responsible ecosystem-based management policies.
7. Involve K-12 teachers and students in learning about marine and estuarine environments through our nationally recognized teacher preparation programs in mathematics and science education.
8. Engage the general public to increase its appreciation and understanding of the importance of coastal management through web-based access and visualization of environmental data.

## Partner Institutions

**CI-CORE** will build on the specific strengths of six CSU organizations and their scientists in northern California. These institutions and their specific strengths are:

**Moss Landing Marine Laboratories.** MLML is the graduate program in marine sciences and marine research facilities serving a consortium of seven CSU campuses. MLML is active in all disciplines of oceanography (physical, geological, chemical and biological) with faculty in marine ichthyology, phycology, invertebrate zoology and higher vertebrates as well. With nine faculty, eight adjunct faculty, several affiliated researchers, 20 undergraduates, 100 graduate students and about 50 staff, MLML has an international reputation for excellence in marine science. In addition, MLML hosts the California Department of Fish and Game's Bay Protection Program, State Musselwatch Program and Marine Pollution Studies Laboratories with expertise in marine pollution and toxicology. The MLML facilities are equipped with a running seawater system, computer network, laboratories, shops, library, small boats (10 feet to 55 feet), and the nation's largest research diving program. MLML also operates a 135-foot research vessel owned by the National Science Foundation and has extensive partnerships with other research institutions around Monterey Bay.

**Romberg Tiburon Center for Environmental Studies.** RTC is a research center whose primary focus is estuarine systems, especially in the San Francisco Bay/Delta. RTC has 15 Ph.D. scientists and an approximately equal number of support staff. Facilities include state-of-the-art, newly renovated laboratories in nutrient chemistry, biological oceanography, marine physiology and physical oceanography, as well as a running bay/sea water system and several small boats. Current areas of expertise and research focus include the effects of introduced (non-indigenous) species on estuarine ecosystems, the effects of contaminants on marine food chains, and fisheries production and harmful algal blooms.

**CSU Hayward.** CSU Hayward has been working with the San Francisco Bay including the coastal and the delta areas for over twenty years. The School of Science at Hayward has an active group of scientists with expertise in environmental science, ecology and conservation biology. They have recently established the Bay/Delta Area Shore Institute (BASIL) to focus on research and restoration of both the delta and the bay shore. BASIL has a shoreline research station in Newark and is currently involved in a joint effort with the City of Alameda to set up a research station in the old Alameda Naval Base. In the past year, BASIL has received a 770K grant from CalFed to do restoration, monitoring and data evaluation in the Delta. CSU Hayward is also a major partner of the Delta Science Center. This Center is dedicated to the preservation and restoration of the Delta through public education, academic education and research.

**CSU Monterey Bay.** CSUMB is located on the shores of Monterey Bay and is the newest of the CSU campuses. The strengths of its science program (Earth Systems Science and Policy) lie in the integration of science, economics and policy related to coastal and marine issues, watershed dynamics and development of GIS-based models. The Monterey Bay faculty includes 20 Ph.D.'s with funded research in the areas of fisheries habitat assessment, seafloor mapping, acoustic and satellite remote sensing, ocean current modeling, development of early warning species to protect the public from toxic plankton blooms, biogeochemical ecosystem modeling, environmental instrumentation, and marine GIS. CSUMB maintains a state-of-the-art seafloor mapping research vessel, and the new ESSP $23 million science center and GIS computer facility is scheduled for completion in 2002. Current science/policy partners include: NOAA, National Marine Fisheries Service, California Department of Fish and Game, National Marine Sanctuaries and Reserves Program, and numerous marine technology partners.

**Cal Poly SLO.** Cal Poly is located along the central coast of California just north of the significant coastal oceanographic boundary of Point Conception. Faculty from Cal Poly SLO have marine research and teaching expertise in phytoplankton dynamics, fisheries, invertebrate zoology, environmental optics, higher vertebrates, and community ecology. Cal Poly faculty research also includes estuarine and watershed studies in and around Morro Bay National Estuary, located 10 miles from campus. In addition to analytical dry laboratories and GIS facilities, Cal Poly's developing infrastructure includes; a pier-based marine facility with an automated profiling system, a running seawater system and small boats.

**San José State University.** SJSU is the operating campus for the MLML Consortium and also houses strong programs in both life and physical science. SJSU is one of the leading institutions in science teacher preparation and professional development in California and is widely recognized on a national scale through innovative programs funded through National Science Foundation and Presidential awards. The data that will be gathered as part of the CI-CORE project will complement current SJSU efforts in providing WWW-based resource materials in ocean science education to K-16 science teachers and the public.

## Approach

CI-CORE will employ an integrative approach to address the major environmental challenges of the northern California marine and estuarine environments. Only by bringing together the expertise that exists on the various campuses can a true understanding of the regional dynamics of this ecologically and economically important area be understood. These challenges must be looked at in a holistic manner, not in isolation. For example, mercury from gold mining in the California foothills has led to high mercury concentrations in sediments of the Sacramento and San Joaquin Rivers. As a consequence, mercury levels in striped bass now exceed FDA limits for human consumption. The *processes*, however, which control the flux of mercury from the sediments into the water and into the food chain are not yet understood. Other examples of challenges to the northern California marine and estuarine environments are listed in Appendix A. To gain full understanding of these problems and their extent, scientists with expertise in biogeochemistry, fisheries, and ecosystem modeling must work collaboratively. The Center will focus on exactly those kinds of applied research problems (e.g., contaminants in marine and estuarine food webs; invasive species and their impacts) which require an inter-disciplinary and multi-investigator approach.

The Center also will establish a network of coupled land margin/coastal time series stations strategically located throughout the northern California region to collect environmental parameters within a meteorological and geo-referenced context. This will allow us to address regional scale problems (e.g., El Nino and La Nina) that would be impossible to study properly at only one site or location. Finally, the Center will develop new ways to help the public and policy makers alike, access, visualize and apply the information derived from these complex and multidimensional environmental data sets via the Internet.

**Appendix A. Challenges to the northern California marine and estuarine environments.**

- **Shipping:** Shipping has had a major impact on the near shore environment both in terms of toxic materials spilled and debris discharge into coastal waterways. Although catastrophic events are easy to assess in the short term, the long-term sub-lethal impacts of both oil spills and bilge discharge on marine birds and mammals are thought to be significant but are as yet unknown.
- **Alien Invasions:** Ballast water from foreign ports discharged dockside in the US harbor invertebrate stowaways. These alien invaders now infest our coastline and estuaries and threaten the biodiversity of our coastal ecosystems. Although the economic value of biodiversity has yet to be assessed, some invasions have direct economic impacts. The zebra mussel invasion of the Laurentian waterways has wrought billions of dollars worth of damage in fouled pipelines and waterways. Other invasions such as the green crab, mitten crab and Asian clam have had major environmental impacts, but are yet to be economically assessed.
- **Fishing:** Commercial fishing has had a major impact on the abundance of commercially important fish species. As the near shore stocks and habitats are depleted or degraded, fishermen target other species and areas about which we know very little. For instance, catches of Pacific Grenadier have just increased by a factor of 400 over the last two years. This species lives to be over 50 years old and is in great danger of being severely depleted. Habitat destruction by fishing gear off the California coast has been shown to significantly reduce biodiversity, but little research has been done to help minimize this damage while preserving fisheries. Many other species and habitats face this same threat.
- **Chemical Contamination:** The coastal oceans are the receiving waters for industrial and domestic wastes, and agricultural runoff. Pesticides, fertilizers and toxic metals are having an increasing impact on the health of the coastal ecosystem in ways, which directly affect both recreational quality and commercial enterprise along our coast. For example, even though DDT was banned in the 1970's, its residue continues to wreck havoc in bird populations exposed to agricultural runoff. This has adversely affected the Caspian Tern populations and mitigation measures have yet to be adopted. Also, mercury from gold mining of the California foothills has led to high mercury concentrations in sediments of the Sacramento and San Joaquin rivers. As a consequence, mercury levels in striped bass now exceed FDA limits for human consumption. The processes, which control the flux of mercury from the sediments into the food chain, are not yet well understood.
- **Human Pathogens:** The role of pathogens in marine systems is not yet well understood. The human epidemiology of some parasites, cholera and enteric bacteria as it relates to fish and shellfish consumption has been well documented. The role of marine borne viruses, protozoa and some amoeba have also been implicated as factors which adversely affect human health but the mechanisms of action and quantitative significance of these pathogens are not yet known.
- **Marine Pathogens:** Although something is known about marine borne pathogens affecting human health, less is known about pathogens in marine populations both vertebrate and invertebrate. The demise of the black abalone along our coast is thought to be the result of a pathogen affecting this species causing what is known as the abalone withering disease. The future of the abalone industry depends upon a better understanding of this pathogen and its affect on its host.

- **Toxic Phytoplankton:** With increasing frequency, toxic phytoplankton blooms threaten our shellfisheries, the marine birds and mammals along our coastline as well as humans who ingest shellfish from contaminated waters. Although there is no doubt that the species responsible for such blooms are occurring more often and in greater abundance, we still do not know what triggers these blooms or the production of neurotoxins commonly associated with them.
- **Land Use:** The watershed and coastal environment function as linked systems. Large, episodic runoff events produce severe chemical and pathogenic contamination in every coastal drainage system throughout central California. Estuarine and near shore environments are the receiving waters for these episodic events and must respond to increased turbidity, sedimentation rates, contaminant introduction, stratification, etc. In addition the estuarine and near shore environments are where the greatest anthropogenic forcing occurs. Land management practices influence many watershed resources (water, soils, nutrients, vegetation, etc.) and are strongly correlated to water quality (pesticides, herbicides, turbidity and nutrients). Responsible land use practices need to be identified and implemented throughout our coastal watersheds for the protection and conservation of both our land and water resources.