The Coastal Monitoring Project

Synopsis of a joint venture between The Scripps Institution of Oceanography and The International SeaKeepers Society
August 2007

Overview

Scripps Institution of Oceanography and The International SeaKeepers Society propose to embark on a joint venture to develop and implement on a pilot basis, the Coastal Monitoring Project. The Project, or CMP for short, leverages the expertise and leadership resident in both organizations in an effort to fill knowledge gaps in the science and understanding of coastal systems.

The world's coastline, serving as the boundary between land and marine systems, is where the majority of our interactions with the ocean take place. With more than 50% of the human population residing along the coast, both the ocean and coastal populations are susceptible to change that is presented in a number of forms; long term climate change, increasing pressures from growing human populations, or coastal hazards that present themselves with little warning. Our coastal ocean, while accounting for only about 10% of the surface area of the ocean, is the region of highest biological productivity and is home to many of the world's greatest fisheries. The CMP will advance our ability to observe the coastal ocean, and will be developed in a manner to serve as a model for global deployment.

Scientists are faced with challenging questions of global importance:

- How do human activities impact the coastal ocean?
- How do coastal ecosystems respond to climate change?
- How does climate change and sea level rise present itself at local scales?
- What role does the coastal ocean play in the global biogeochemical cycles that control climate change?
- What processes determine community structure in coastal ecosystems?
- How can we predict and mitigate coastal hazards that impact human populations?

At present, our ability to answer these and other critical questions is limited by our gaps in knowledge, due in part to the cost and difficulty of making long-term measurements in this rigorous environment. The CMP will close this gap, implementing the best of new sensor technologies in a modular system to facilitate deployment, operations, and maintenance. Data and communication standards will be established to facilitate the transfer of data from the expanding network to scientists around the world.

Developing the Coastal Monitoring Project – A Pilot

The program will be lead by Dr. Eric Terrill, Director of the Coastal Observing Research and Development Center (CORDC) located at Scripps Institution of Oceanography. Dr. Terrill, with a background of designing and operating new ocean sensing technologies for coastal science applications, has spent the last two years evaluating the existing SeaKeeper 1000^{TM} ocean-monitoring module from the Scripps Pier in La Jolla to identify what technologies can be efficiently leveraged from this vessel-based, open-ocean system to a new version designed for coastal monitoring.

Scripps has a rich history in implementing global observational networks, including the well-known Keeling carbon dioxide measurements used to document climate change, global arrays of drifters to monitor ocean surface circulation and sea surface temperatures, and the ARGO network of global profiler, which monitor global ocean temperatures to 2000m depth and deep sea circulation. The CMP is a natural extension of Scripps's expertise in developing and deploying new technologies in a sensible and efficient manner that allows broad access to the data by scientists, resource managers, and decision makers.

In the near term, the CMP will focus on a pilot, three-year effort to implement the next generation of SeaKeeper technology, designed in partnership with Scripps. Six piers in Southern California will be targeted for the deployment of the new technology and serve as a test bed for learning how best to develop a global network of coastal observations. Southern California is an ideal location for this activity, not only for the broad set of

offshore measurements that will be integrated with the data, but for the immediate opportunities for inserting better science and data into policy decisions.

The Southern California bight (approximately the region from Santa Barbara extending the U.S. - Mexico Border) is characterized by a population of 20 million inhabitants living within 50 miles of the coast (and coincidentally, represent 25% of the total coastal population of the US), a beach usage greater than the other 49 states combined, and a $10 billion tourist economy of 175 million users that depends on a healthy coastline. The CMP not only represents an investment to develop new science and technology, but presents an opportunity to deliver better science to enhance local policy decisions. In this regard, the pilot effort will provide guidance for both overcoming the technical challenges of implementing a global network of coastal observations and how best to interpret and present those observations for local decision makers.

Specifics – What is Measured and Costs to Implement the CMP

The pier-based system will provide continuous measurements, in near-realtime of the following variables:

- ***Coastal meteorological conditions –*** Understanding and predicting how the atmosphere and ocean interacts requires measurements of meteorological conditions including wind speed and direction, air temperature, barometric pressure, relative humidity, and solar radiation including UV. Coastal winds are also critical to understanding sea state and transport of atmospheric pollutants.

- ***Sea level change, including the height and period of ocean waves*** – Measurements of sea level will be measured accurately and rapidly using a scientific-grade pressure sensor to resolve sea level fluctuations across a continuum of timescales. Rapidly sampling a time series of pressure fluctuations will allow the resolution of ocean waves, tides, storm surge, seasonal, and climate-driven sea level change at each deployment site. Conducting measurements of these secular changes in water height with stable and accurate sensors, referenced to a land-based vertical datum, will provide a valuable record of sea level change and its along-coast variation.

- ***Ocean temperatures and stratification*** – Ocean water temperatures will be measured at several depths to observe how the internal structure of the ocean responds to forcing from storms and tides. Recent observations from the Scripps Pier indicate that tidal surges of deeper cold water from offshore can present themselves at the shoreline and dramatically change the depth of the thermocline over timescales of hours. It has been suggested that this tidal surge process, whose cooler waters are also nutrient rich, contributes to the complexity of nearshore ecosystems and could be a controlling factor in some coastally trapped algal blooms. Understanding the vertical structure of the ocean also provides context for the fixed depth intake of the SeaKeepers' module.

- ***Ocean salinity –*** Changes in the salinity of coastal waters can be indicative of influences from land-based, fresh water sources. Relationships between temperature and salinity also allow oceanographers to assess different 'water masses' – a useful tool for identifying changes in local ocean properties. Ocean salinities will be measured with an oceanographic conductivity probe, whereby the salinity of the ocean is computed through a relationship between conductivity, temperature, and salinity.

- ***Water quality variables such as turbidity and dissolved oxygen*** – Development of new modules for rapidly assessing water quality will be integrated into the system. An initial focus will be on the use of optical sensors for measuring oxygen and turbidity of the water, as these parameters can be used to assess marine ecosystem health and indicate the presence of land-based inputs. Fine-grain suspended sediments, a leading cause for high turbidity, can negatively impact filter-feeding plants and animals, while variations in dissolved oxygen can impact the respiratory functions of animals.

- ***Nutrients (nitrate) –*** Nutrients, which represent a food source for the lowest levels of the food chain, can control the structure of the ecosystem, and can originate from both deeper ocean waters and land-based runoff. Little is known about the flux of nutrients in our coastal zone, and how physically forced fluctuations in nutrients will control episodic biological events such as algae blooms. Only recently has technology become available for making continuous measurements of nitrate, a primary nutrient of interest to scientists. The Pilot program will initially focus on testing, evaluating, and deploying these new sensors, with expansion to include other sensors for phosphates and silicates as those sensor technologies mature.

- ***Colored Dissolved Organic Matter (CDOM) –*** CDOM is the component of the water that is a result of organic detritus deteriorating. The tannins released during this process create an optical signal which can be detected using fluorescent techniques. Organic detritus naturally occurs in the ocean as phytoplankton decay; however increased human/land-inputs, which include additional nutrients, will lead to increases in both phytoplankton growth and decay. CDOM can also indicate point source pollution, storm water, or draining wetlands. An optics-based sensor, suitable for integration into the SeaKeepers' system, will be tested, evaluated, and deployed to complement the other suite of sensors described.

The suites of sensors required to measure these variables will be evaluated at Scripps, quality-controlled against standard oceanographic methodologies and laboratory analysis procedures, and packaged in a manner to minimize cost of operation. Challenges will include preventing bio-fouling and sedimentation. Principles of modularity, a hallmark of the SeaKeeper 1000's success, will be adhered to for this next-generation system. Due to the rapid timescales of change in the coastal environment, many of the variables will require sampling at rates between once per second to once per minute. As a result of this significant increase in data, a suitable data and communication system will be deployed

that leverages existing advancements developed by Scripps. Data will be made available for testing and validating forecast models of coastal climate change.

FUNDING REQUIREMENTS: The Coastal Monitoring Project will require an investment of $1,100,000 over three years. $1M will be directed to Scripps Institution of Oceanography and $100k will support Seakeepers staff to interface with Scripps on the project.

Milestone Schedule:

The following milestone schedule is proposed for this project.

Year 1: Develop and fabricate new shoreline monitoring system with capabilities as described within the white-paper. Deploy system from the Scripps pier and evaluate against laboratory standards. Begin siting procedures for systems 2-3. Begin development of new data handling system for the real-time network. Provide annual update to Seakeepers on program progress.

Year 2. Continue quality control and assessment of proto-installation at Scripps Pier. Fabricate systems 2-3 and install sites in Southern California. Complete development of data handling system. Launch public web site for access to data and results from initiative. Transmit quality controlled data to national data centers if appropriate. Provide annual update to Seakeepers on program progress.

Year 3. Fabricate systems 4-6 and install. Operate and maintain entire network. Document operations and management needs for the network. Continue improvements to public website, including development of coastal assessment products based upon interpretation of data from the Southern California network.

Potential Site locations –South to North:

1. Imperial Beach Pier
2. Scripps Pier
3. Huntington Beach Pier (alternate – Newport or Balboa Pier)
4. Twin Harbors Pier – Catalina
5. Santa Monica Pier
6. Santa Barbara Pier

A map of existing piers in Southern California is shown in figure 1.

Figure 1. A map of existing pier locations in Southern California. The Coastal Monitoring Project will develop monitoring sites at six locations in the region.

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Seakeepers

Year 1: January 1, 2008 through December 31, 2008

SALARIES & BENEFITS	**FY**	**Monthly Recharge Rate**	**No. Mos. Effective**	**% Salary or Effort**	**Total Person Mos**	**Subtotal**	**TOTAL**
			Total person months		16.50		
						SALARIES AND BENEFITS TOTAL	**134,548**
LABORATORY SUPPORT SERVICES			**22% of Total Labor less Overtime				**29,601**
PROJECT SPECIFIC SUPPLIES, MATERIALS, & OTHER EXPENSES:							
						SUPPLIES & OTHER EXPENSES TOTAL	**24,338**
EQUIPMENT (or equivalent and includes sales tax)							
Fabrication of Pier Sampling System:							
						EQUIPMENT TOTAL	**55,800**

TRAVEL		*Car/RF*	*No. of*	*No. of*		
Domestic	*Airfare*	*Per Diem*	*Days*	*Trips*	*Total*	
					TRAVEL TOTAL	**15,340**
					TOTAL DIRECT COSTS	**259,627**

INDIRECT COSTS (less equipment, tuition remission, subcontract cost in excess of $25K)

		Base	OH Rate		
Tuition:	*0*				
Equipment:	*55,800*	203,827	0.0%	0	
Excluded from Indirect	*55,800*				
				TOTAL INDIRECT COST	**-**
				TOTAL AMOUNT REQUESTED	**259,627**

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Year 2: January 1, 2009 through December 31, 2009

SALARIES & BENEFITS	**FY**	**Monthly Recharge Rate**	**No. Mos. Effective**	**% Salary or Effort**	**Total Person Mos**	**Subtotal**	**TOTAL**
			Total person months		17.50		
						SALARIES AND BENEFITS TOTAL	**150,317**
LABORATORY SUPPORT SERVICES			**22% of Total Labor less Overtime				**33,070**
PROJECT SPECIFIC SUPPLIES, MATERIALS, & OTHER EXPENSES:							
						SUPPLIES & OTHER EXPENSES TOTAL	**24,644**
EQUIPMENT (or equivalent and includes sales tax)							
Fabrication of Pier Sampling System (See Y		2 @		$ 55,800	/ea	111,600	
						EQUIPMENT TOTAL	**111,600**

TRAVEL		*Car/RF*	*No. of*	*No. of*		
Domestic	*Airfare*	*Per Diem*	*Days*	*Trips*	*Total*	
					TRAVEL TOTAL	**15,859**
					TOTAL DIRECT COSTS	**335,490**

INDIRECT COSTS (less equipment, tuition remission, subcontract cost in excess of $25K)

		Base	OH Rate	
Tuition:	*0*			
Equipment:	*111,600*	223,890	0.0%	0
Excluded from Indirect	*111,600*			
			TOTAL INDIRECT COST	**-**
			TOTAL AMOUNT REQUESTED	**335,490**

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Year 3: January 1, 2010 through December 31, 2010

SALARIES & BENEFITS	**FY**	**Monthly Recharge Rate**	**No. Mos. Effective**	**% Salary or Effort**	**Total Person Mos**	**Subtotal**	**TOTAL**
			Total person months		18.00		
						SALARIES AND BENEFITS TOTAL	**164,463**
LABORATORY SUPPORT SERVICES			**22% of Total Labor less Overtime				**36,182**
PROJECT SPECIFIC SUPPLIES, MATERIALS, & OTHER EXPENSES:							
						SUPPLIES & OTHER EXPENSES TOTAL	**24,160**
EQUIPMENT (or equivalent and includes sales tax)							
Fabrication of Pier Sampling System (See Year 1 for cost b							
			3 @	$ 55,800	/ea	167,400	
						EQUIPMENT TOTAL	**167,400**
TRAVEL							
Domestic		*Airfare*	*Car/RF Per Diem*	*No. of Days*	*No. of Trips*	*Total*	
						TRAVEL TOTAL	**12,678**
						TOTAL DIRECT COSTS	**404,883**
INDIRECT COSTS (less equipment, tuition remission, subcontract cost in excess of $25K)							
Tuition:		*0*	Base	OH Rate			
Equipment:		*167,400*	237,483	0.0%		0	
Excluded from Indirect		*167,400*					
						TOTAL INDIRECT COST	**-**
						TOTAL AMOUNT REQUESTED	**404,883**