Attachment A

SUPPLEMENTAL ENVIRONMENTAL PROJECT (SEP)

Administrative Civil Liabilities (R1-2000-23)

FINAL SEP PROPOSAL

Proposed by

UC BODEGA MARINE LABORATORY

15 DECEMBER 2008

Bodega Marine Laboratory (BML) (http://www-bml.ucdavis.edu/) proposes to monitor pH in the coastal ocean offshore of the Sonoma coast to document trends in ocean acidification.

Background:

Since the industrial revolution, it is estimated that surface ocean pH has dropped by approximately 0.1 units, and it is estimated that it will drop by a further 0.3 - 0.5 units by 2100 as the ocean absorbs more anthropogenic CO_2. The "acidification" (or, as the pH of seawater remains above 7, it is more correct to refer to the "de-alkalinification") of seawater resulting from anthropogenic input of CO2 is increasingly attracting the attention of oceanographers, biologists, atmospheric scientists. Rising atmospheric CO2 concentrations are expected to cause decreases in pH and the carbonate saturation state of ocean water, with expected detrimental effects on organisms that precipitate calcite or aragonite shells. Calcifiers span the food chain from autotrophs to heterotrophs and include organisms such as coccolithophores, corals, foraminifera, echinoderms, crustaceans and molluscs. While the full ecological consequences of these changes in calcification are still uncertain, it appears likely that many calcifying species will be directly and adversely affected. Aside from calcification, organisms may suffer other adverse effects, either directly as reproductive or physiological effects (e.g. CO_2-induced acidification of body fluids), or indirectly through negative impacts on food resources (some calcifiers are primary producers).

In the coastal ocean, pH is controlled by several processes: the influx of CO2 from the atmosphere; upwelling of old, low pH (high CO2) water; runoff of freshwater from rivers and streams (low pH, acidic water); and the balance of photosynthesis and respiration by plants and organisms in the surface ocean. Recent oceanographic surveys in northern California have indicated that upwelling regions, like the one offshore Bodega Head, are likely "hotspots" for ocean acidification impacts: the cold, upwelled water along the northern California coast absorbs more CO2 than warmer water, and thus rate of acidification is greater than in coastal areas not experiencing upwelling.

Although it is projected that the largest changes will occur in the future, a report from

NOAA scientists recently found large quantities of water under-saturated in aragonite are already upwelling close to the Pacific continental shelf area of North America. Continental shelves play a critical role in marine ecosystems as most marine organisms live or are spawned there, and though the study only dealt with the area from the west coast of the U.S. between Canada and northern California, the authors suggest that these results may be pervasive across other shelf regimes. Few studies have undertaken the long-term empirical observation of pH, but a dataset examining temporal variations in pH at a temperate coastal location found that acidification was occurring at a rate much higher than that previously predicted, with consequences for near-shore benthic ecosystems.

Monitoring pH in the coastal ocean in an upwelling center is the first step toward gaining an understanding of its rate of change on daily, seasonal and long-term time scales. These data will provide a baseline on the total range of pH that coastal organisms experience, which will in turn inform laboratory-based research at BML focused on determining the projected impacts of decreasing ocean pH on organisms and communities. Further, as the pH of coastal ocean water changes, the expected impact on the ocean's ability to absorb CO2 will have implications for climate change.

Given that all indications are that the pH is changing at a historical rate in coastal oceans, California urgently needs to begin collecting baseline pH data. A growing database will inform researchers from multiple disciplines – oceanographers, ecologists, biologists – about what effects this change will have on coastal systems and how to prepare for potential impacts.

Proposal:

BML presently maintains an oceanographic mooring located at 38 18.704N and 123 05.003W along the 30 meter isobath (just over a half mile west of BML). This mooring provides hourly data on water quality parameters such as temperature, salinity, fluorescence, and transmissometry. Additionally, it is fitted with an acoustic Doppler current profiler (ADCP) that collects data on current speed and direction throughout the water column. Data are delivered through WiFi connection or YSI radio to a receiver at BML, and downloaded daily onto a dedicated server. Many of the onboard sensor data is graphically visualized or available in tabular form on BML's "Bodega Ocean Observing Node" (BOON) webpage: http://www.bml.ucdavis.edu/boon/. This project will be led by resident BML faculty who have donated resources to this effort, and BML's Assistant Director of Operations.

BML proposes to install a new, state-of-the-art spectrophotometric pH (SAMI-pH from Sunburst Sensors, see attached) sensor for high-resolution (hourly) pH measurements. This unit will be added to the existing sensor suite, and data will be logged onboard the mooring by a datalogger, and uploaded daily to the server.

Installation of the SAMI-pH sensor requires a significant modification to the mooring, including power source, battery storage, plumbing, electrical connection to the data logger, and novel software code that will capture, archive, QA/QC data. The data are then

delivered to our BOON webpage which will be updated at least daily. Metadata related to this sensor will also be posted on the BML BOON website in a form that allows data sharing with other registries.

Once deployed, this sensor requires ongoing maintenance to assure data quality. Each month, the mooring will be visited by a technician and divers to clean the sensor (located below the mooring, thus requiring SCUBA) of biofouling, check battery voltage, functioning of unit, and changing of consumed reagents as required by sensor (every 3 months). This service requires vessel support, and the BML research vessel *Mussel Point* will be used.

There are two goals related to data collection: (1) Public access of realtime data that are routed from sensor on the mooring to the server to the web. These data are downloaded daily, and available in tabular or graphical form. (2) Public access to *archived* data as the database grows requires significant additional programming. Our goal here is to build a site where users can log in, describe parameters they're interested in (e.g. dates, times, frequency, etc.) and get those data in a file. This level of data-sharing builds on a growing data collection infrastructure among numerous entities that allows users access to multiple data sources, thus synergistically broadening our ocean observing capabilities. While we will in good faith attempt to implement this second goal, we cannot guarantee we will be successful. If we fail to get this programming done, the balance of the project will still meet the requirements of the SEP.

BODEGA MARINE LABORATORY

Time and cost budget for pH data collection from oceanographic mooring:

Material Cost

Purchase:	***Item:***	***Date:***	***Staff:***	***Hours:***	***Cost:***
Saml pH meter	Sunburst sensors: http://www.sunburstsensors.com/products-pHfresh.html	Nov-08		N/A	$ 20,039.38
Sound Ocean Systems, Inc	Integration of pH sensor in to oceanographic mooring, incl. shipping	Dec-08		N/A	$ 4,400.00
Reagents for calibration (4x/year)	Consumed by sensor during operation	Jan-09		N/A	$ 300.00
Batteries (2x/year)	For sensor operation, independent of other onboard sensors	Jan-09		N/A	$ 230.00
Vessel Support*	Sensor nstallation/monthly maintenance	1 yr		48	$ 8,592.00

Labor

One Time:

pH sensor set up (config parameters calibrate), delivery to SOSI (WA) for integration on mooring	Dec-08	MT		$ 650.00
Data to on board data logger: set up and testing	Feb 09	DM		$ 800.00
		MT		$ 2,500.00
Set up remote data communications via WIFI antenna to dedicated BML server	April	P		$ 3,000.00
		MT		$ 1,400.00
Archive raw data, convert to pH, QA/QC	April	P		
		DM		$ 2,100.00
Metadata collection, web posting, sharing values with other registries	April	MT		$ 800.00
Data delivery to BML BOON website: tabular, or possible graphical visualization using LabView	May	P W		
Public access of archived data: programming solutions to serve up data	Dec	P		$ 4,500.00
		W		$ 3,500.00
Final report: Data interpretation		M		$ 2,000.00
		F		$ -

Labor (cont'd)				
Ongoing maintenance:				
Change reagent every 3 mo: Vessel support to mooring/2+ SCUBA divers		DT	18	$ 612.00
Clean sensor of biofouling monthly: Vessel support to mooring/2+ SCUBA divers		DT	60	$ 2,040.00
Sensor Troubleshooting		MT	30	$ 960.00
Webpage updates, maintenance		W	40	$ 1,400.00

TOTAL:	$59,823.38

LEGEND

Staff Title	Rate
MT = marine Technician	$ 32.00
P = Programmer	$ 40.00
W = Webmaster	$ 35.00
DM = Data Manager	$ 43.00
DT = Diver/Technician	$ 34.00
PP = Physical Plant	$ 40.00
M = Manager	$ 51.00
F = Faculty/Researcher	$ -

*Vessel Support: 4hrs/month at $179/hr x 12 months = $8592